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PROGRESS IN SOIL AND WATER CONSERVATION RESEARCH

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Report for April-June 1958 Issued July 1958

CONTENTS

Washington

MANNING'S "n" FOR IRRIGATION FURROWS DETERMINED

Stephen J. Mech, Prosser.--Manning's equation $n = \frac{1.486}{V} r^{2/3} s^{1/2}$, where V = mean velocity, r = hydraulic radius, s = hydraulic gradient, and n = coefficient of roughness, was solved for "n" for different crops irrigated with a grade of 2 percent and 7 percent in the furrow channel. Three soil moisture treatments and 3 nominal stream sizes were applied on each grade.

The basic flow data were obtained for crops in a 7-year rotation. Velocity determinations were based on the time required by a drop-in-head impulse to travel over the 250-foot plots. This time was determined by obtaining the difference between the time the water was turned off at the top of the plot and the time this impulse was recorded on the runoff charts.

The "Q" was the average of the application and runoff rates for the irrigation on which the velocity was determined.

Figure 1 shows how the average "n" for the season varied for the different crops. These values were computed for a triangular-shaped channel with 1:1 side slopes. Values computed for a rectangular channel with the width equal to twice the depth were essentially the same.

Figure 2 shows how the "n" varied during the irrigation season on 1949 sugar beets. Row crops generally showed an increase in "n" beginning about midseason. This increase is attributed to the increased vegetative growth extending into the water channel and to the secession of cultivation and ditching. Alfalfa and wheat, on the other hand, showed a fairly uniform "n" throughout the season.

Idaho

WATER DEPTH IN ROOT ZONE AFFECTS IRRIGATION EFFICIENCY

Claude H. Pair, Boise.--Irrigation efficiency studies on the Black Canyon Irrigation Experimental Tract near Caldwell, Idaho, indicate that field irrigation efficiency increased with depth of water retained in the root zone.

Under the conditions of this experiment, overall efficiency was highest with the sprinkler method of water application, and lowest with the contour furrow system. The efficiency of downslope furrows, downslope borders, and contour borders was intermediate as shown in the accompanying table.

Comparison of field irrigation efficiency with method of irrigation, Black Canyon Irrigation Investigations, Boise, Idaho

Irrigation method	Determinations	Mean amount of water retained in profile each irrig.	Mean irrigation efficiency
	Number	*Inches*	*Percent*
Contour border.....	22	3.46	66.1
Sprinkler.....	41	2.75	61.4
Downslope border.....	24	3.38	47.4
Downslope furrow.....	35	3.34	40.3
Contour furrow.....	10	3.46	33.5

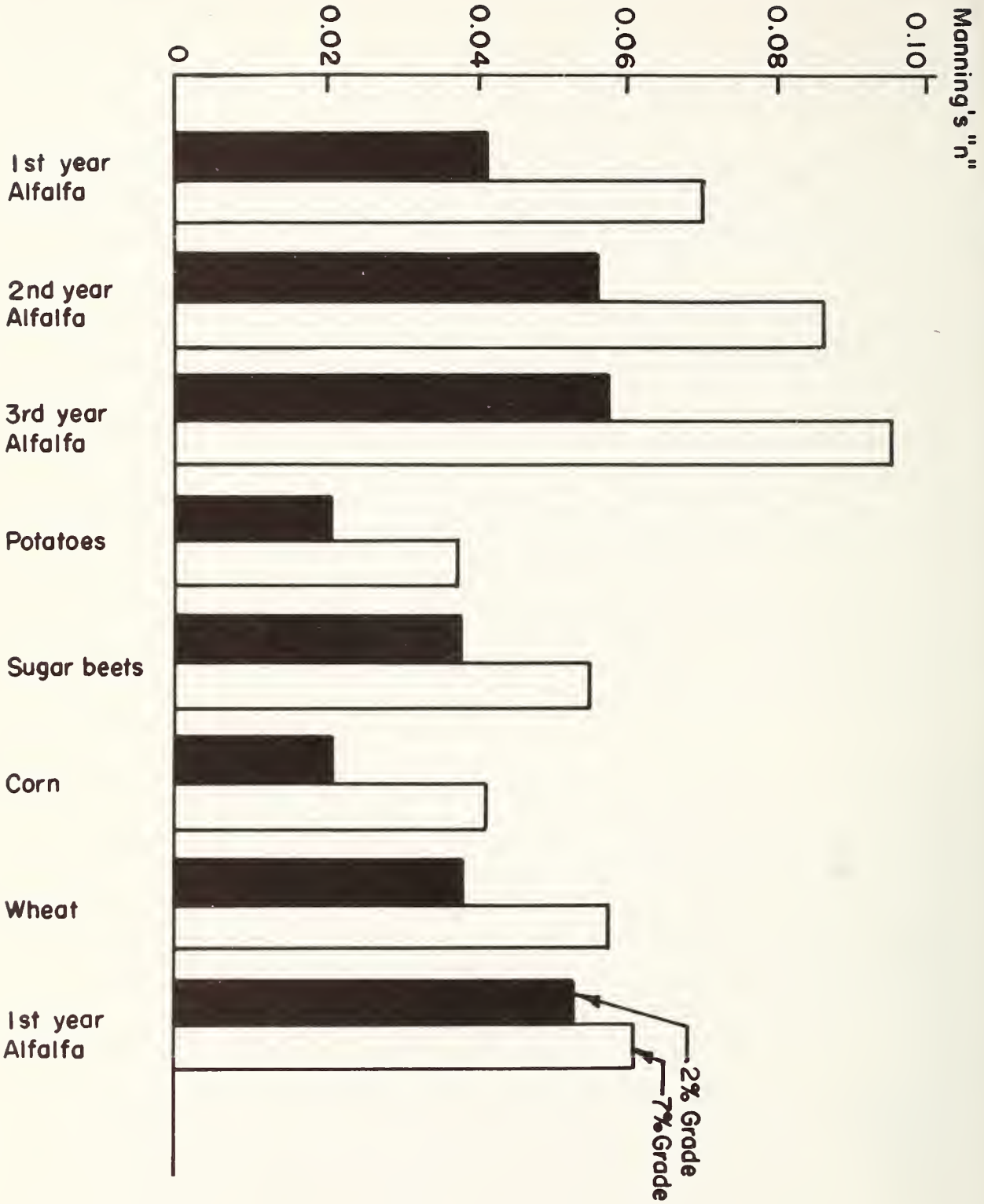


Figure 1.--Influence of crop and furrow grade on the season's average value of Manning's "n", Prosser, Wash.

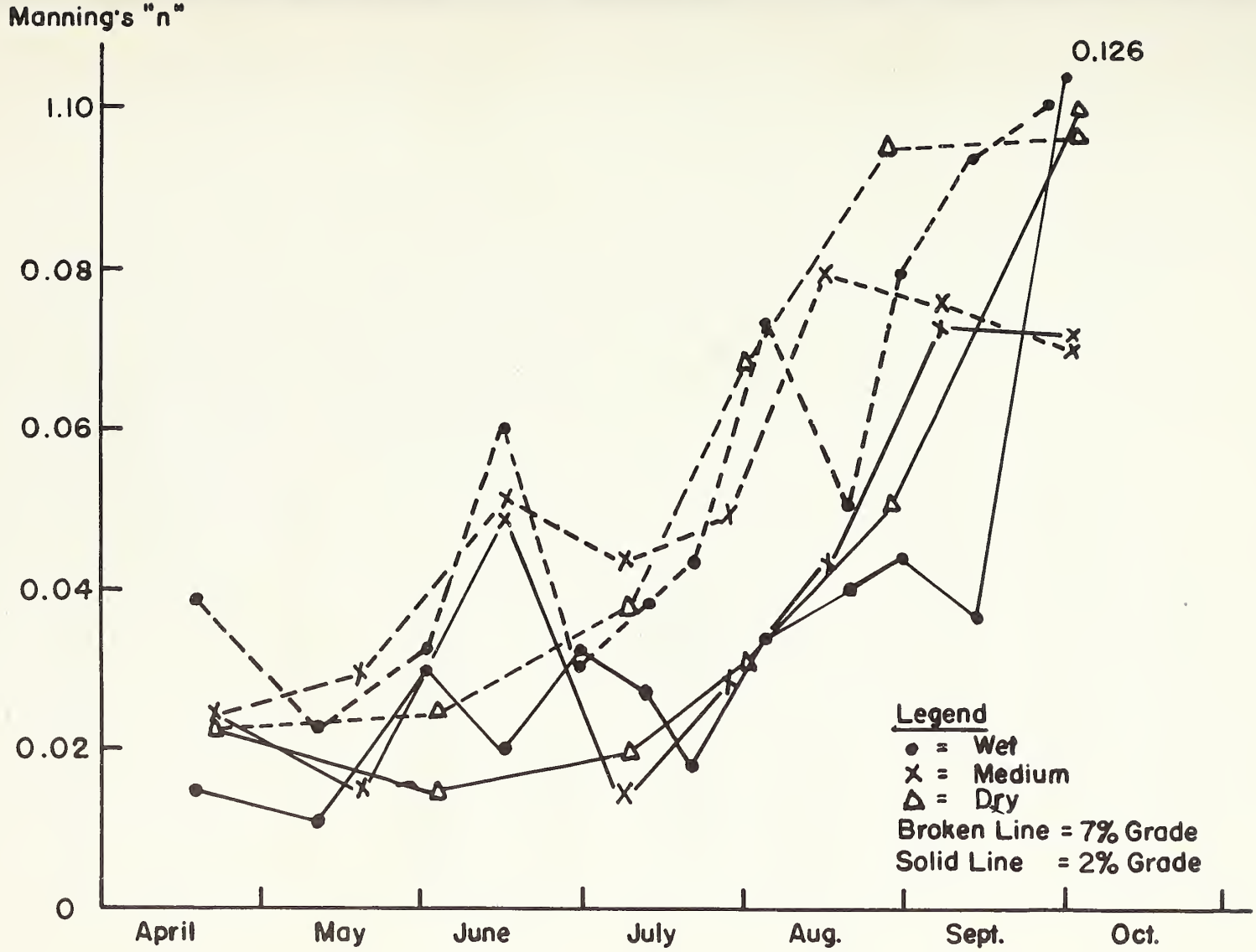


Figure 2.--Variation of Manning's "n" during 1949 irrigation season on sugar beets as influenced by moisture and furrow grade, Prosser, Wash.

The relationship between the amounts of water retained in the soil profile root-zone and the irrigation efficiency is shown in the accompanying figure as a mean regression line for each method of irrigation. Also shown is the regression equation and the sample coefficient of correlation for each method. A comparison of the mean regression lines shows that sprinkler irrigation gave better irrigation efficiency on the small-depth applications, and the contour border gave the best irrigation efficiency for the larger depth of application.

The soils on which the efficiency tests were run are predominately the Chilcott series with small areas of Sebree intermixed in the field area. The land slopes vary from 3 to 5 percent. The root zone was limited to 2 feet by a lime hardpan. The basic intake rate was 0.15 inch per hour. Cropping rotation on the fields was barley, sweetclover (2 years), barley, and alfalfa (3 years.)

Montana

CONSUMPTIVE USE HIGHER ON FERTILIZED WESTERN WHEATGRASS

Sterling Davis and Gilbert A. Schumaker, Chinook.--Consumptive use rates for Western Wheatgrass tended to be higher on fertilized plots (400 pounds of nitrogen/acre) than on check plots according to one year's results at Chinook. These results were obtained on Bowdoin clay, a slowly permeable and difficult to manage soil. Most of the root activity is confined to the upper 2-foot soil profile.

The results presented in the accompanying table show periodic consumptive use, consumptive use rates, and yield, with and without nitrogen fertilizer additions, and for each of 3 irrigation treatments. The overall average increase of 30 percent in consumptive use rates on fertilized plots gave a corresponding 6-fold increase in production of Western Wheatgrass under conditions of this experiment. Some of the short term periodic differences in consumptive use rates due to nitrogen fertilizer were as great as 0.10 inch per day (May 27--wet irrigation treatment).

Utah

BURIED PLASTIC AND CONCRETE LININGS FOR CANALS COMPARED

C. W. Lauritzen, Logan.--Cost studies of a buried plastic film lining and a comparable concrete lining were made of a canal lining job in the vicinity of Ferron, Utah.

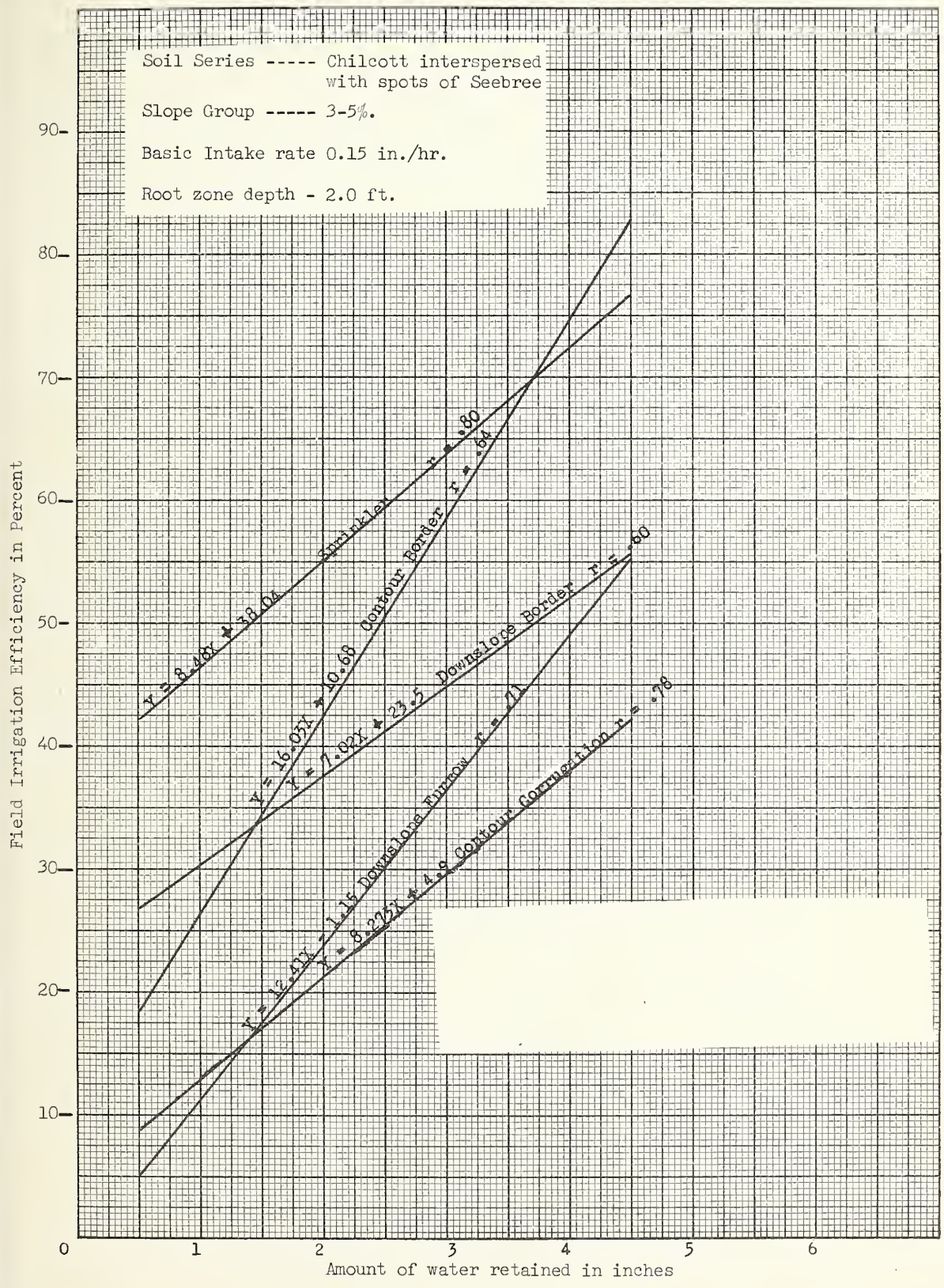
It is evident from these studies that plastic film linings in canals are not nearly so competitive as they are in reservoirs with some of the more standard types of linings, such as concrete. In reservoirs, the capacity per unit area of lining is the same regardless of the type of lining used, while in canals the lined area differs with the type of lining.

The cross section and hydraulic characteristics of these linings are shown in the accompanying figure. It is important to note that wetted perimeter of the finished canal surface for the buried plastic lining is only 20.8 feet. An additional 11.48 feet of film is required because of the overexcavation to allow for covering and a free board of 0.5 of a foot. The cross section of a concrete-lined canal of the same capacity shows a wetted perimeter of 12.46 feet, and an overall perimeter of 14.26 feet allowing 0.5 of a foot for free board.

Assuming the cost of preparing the canal for lining to be the same for each type of lining, the following comparison results:

Plastic film installed, per linear foot of lining - $2.51

Concrete lining installed per linear foot of lining:
with ready-mix concrete @ $18.00/cu. yd. - $3.09
with ready-mix concrete @ $12.00/cu. yd. - $2.30



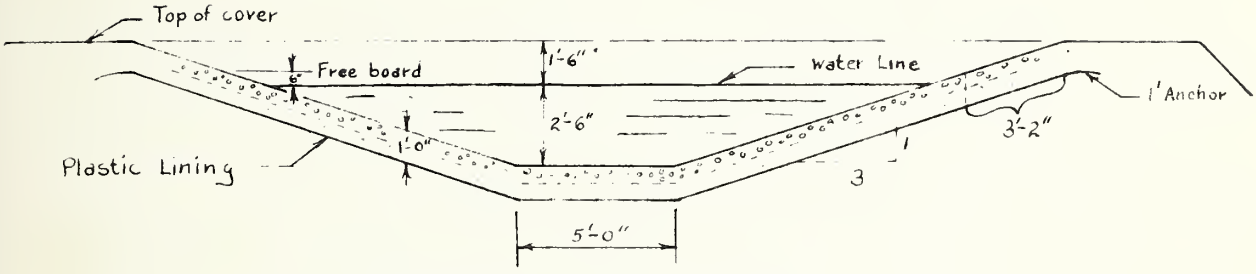
Variation of field irrigation efficiency with depth of water retained in the soil profile under contour corrugation, downslope furrow, downslope border, contour border, and sprinkler methods of irrigation, Boise, Idaho.

Effect of nitrogen on consumptive use by Western Wheatgrass, Chinook, Mont., 1957

Irrigation treatment	Beginning of sampling period	Nitrogen applied per acre	Consumptive use for sampling period	Duration of sampling period[1]	Consumptive use per day	Yield per acre
	Date	*Pounds*	*Inches*	*Days*	*Inches*	*Tons*
Dry	May 17	0	4.52	46	0.10	
		400	4.60	46	0.10	
	July 19	0	2.14	26	0.08	
		400	2.81	26	0.11	
	Average	0			0.09	0.25
		400			0.11	1.50
Med	May 27	0	1.83	16	0.11	
		400	2.46	16	0.15	
	June 21	0	5.53	24	0.23	
		400	4.92	24	0.21	
	July 23	0	1.40	7	0.20	
		400	1.97	7	0.28	
	August 5	0	1.87	21	0.09	
		400	3.59	21	0.17	
	Average	0			0.16	0.40
		400			0.20	2.50
Wet	May 27	0	0.59	7	0.08	
		400	1.28	7	0.18	
	June 10	0	3.24	21	0.15	
		400	4.27	21	0.20	
	August 5	0	1.72	15	0.11	
		400	1.72	15	0.11	
	Average	0			0.11	0.50
		400			0.16	3.25
Average--all irrigation treatments		0			.13	0.40
		400			.17	2.40

[1] Periods less than 7 days between sampling dates not used.

PLASTIC LINING



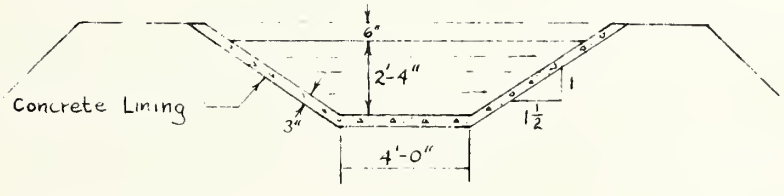
HYDRAULIC PROPERTIES

A	V	Q	r	n	S	d
31.25	2.46	76.9	1.5	0.025	0.001	2.5

Perimeter (wetted perimeter + free board) = 20.8 + 3.16 = 23.96'

Width of film required = 23.96 + 6.32 (Due to over exc. of 1 foot) + 2' (for anchoring) = 32.28'

CONCRETE LINING



HYDRAULIC PROPERTIES

A	V	Q	r	n	S	d
17.65	4.23	75	1.415	0.014	0.001	2.35

Wetted Perimeter = 12.46

Lined Perimeter = 14.26 (Allowing 0.5ft Free board)

Missouri

MODERATE IRRIGATION ECONOMICALLY BEST FOR CORN

V. C. Jamison, E. M. Kroth and J. F. Thornton, Columbia.--In Missouri more corn was produced per inch of irrigation water when water was used conservatively, even though more corn was produced with liberal and frequent applications. Irrigation water has been applied to corn during nine out of the last ten years at the Midwest Claypan Experiment Farm at McCredie. Increases for irrigation in years where water was applied varied from 11 to 78 bushels per acre (table 1). For this ten-year period an average yield increase of 34 bushels was obtained with an average application of 5.3 inches of water. Where farm ponds are constructed and used as the source of water, irrigation costs can be estimated at about $4.00 per inch applied. At this rate the extra corn from irrigation would have cost an average for the period of $0.61 per bushel.

Although less corn may be produced with moderate use of water, the cost per bushel may be somewhat lower than with ample irrigation. In 1956, on plots where the soil moisture was not allowed to drop lower than a 2-inch deficit below the total available soil storage capacity in the upper four feet, corn yields were not much greater than where moisture was applied at a drier level (4-inch deficit) or where soil was kept wet only during the tasseling to dent stage (Table 2). For irrigation at the 2-inch deficit, 10.4 inches of water were needed to produce 145 bushels at an estimated cost of $1.74 per bushel for the extra corn produced by irrigation. Irrigation at the 4-inch deficit required only 4.0 inches of water to produce 140 bushels at an estimated cost of $0.84 per bushel for the increase due to irrigation. Where the water supply is limited or the irrigation system can be used to greater advantage on other crops, it is more economical to use water conservatively on corn even though greater corn yields may be obtained with liberal and frequent water applications.

TABLE 1.--Effect of irrigation on yield of corn grown on Mexico silt loam, McCredie, Mo., 1948-57

Year	Rainfall and runoff June-August[1]		Irrigations		Corn yield per acre		
	Rainfall	Runoff	Times	Amount	No. Irri.	Irri.	Yld. increase
	Inches	*Inches*		*Inches*	*Bushels*	*Bushels*	*Bushels*
1948.....	17.44	4.23	1	3.4	95	137	42
1949.....	14.52	.83	2	2.0	95	106	11
1950.....	10.40	.19	2	4.9	76	97	21
1951.....	13.09	.94	None	None	106	[3] 101	-5
1952.....	10.50	.02	3	3.7	75	101	26
1953.....	3.93	.12	1	1.8	51	79	28
1954.....	7.98	.25	3	8.4	2	75	73
1955.....	10.50	.17	2	10.5	77	155	78
1956.....	13.78	1.50	2	10.4	121	145	24
1957.....	9.55	2.12	3	8.0	62	103	41
Average....	[2] 11.17	1.04	1.9	5.3	76	110	34

[1] From similar plots not irrigated.
[2] Long period (66 year) average, 11.72.
[3] Yield on plots that normally would have been irrigated.

TABLE 2.--Effect of conservative use of irrigation on corn, Mexico silt loam, McCredie, Mo., 1956

Treatment	Water applied	Yield			Cost of increase per bushel**
		Per acre	Increase[1]		
			per acre	per inch water	
	Inches	*Bushels*	*Bushels*	*Bushels*	*Dollars*
No irrigation.....	None	121	---	---	---
Irrigation at 2-inch deficit...	10.4	145	24	2.30	1.74
Irrigation at 4-inch deficit...	4.0	140	19	4.75	0.84
Irrigation tasseling to dent... (2-inch deficit)	4.5	142	21	4.67	0.86

[1] Increase over no irrigation.
**Assuming $4.00 per inch as cost of water applied.

Virginia

IRRIGATION FROM KNEE-HIGH TO BLOOM IS BEST FOR BURLEY TOBACCO

J. Nick Jones, Jr., J. E. Moody and J. H. Lillard, Blacksburg.--Irrigation applied to Burley tobacco during the period from knee-high to bloom gave yield increases equal to full season irrigation. Research data over a four-year period, supporting this conclusion, are given in the table.

A four-year study, during which both rainfall distribution and total amounts varied widely from year to year, showed the average amount of irrigation required for the full season treatment was 5.5 inches, while the knee-high to bloom treatment required only 3.3 inches. The yield increase per inch of water applied averaged 100 pounds per acre on the knee-high to bloom treatment and only 45 pounds per acre on the full season treatment.

The values given for the tobacco are based on actual warehouse sales. Therefore, these values are more nearly a reflection of market conditions than of true tobacco quality.

Although there may be occasional years when severe early season droughts would necessitate earlier applications, these data indicate that generally Burley tobacco irrigation restricted to the knee-high to bloom period will provide the highest returns and greatest water utilization efficiency.

Georgia

SEVERAL EVAPOTRANSPIRATION ESTIMATIONS APPEAR RELIABLE

G. N. Sparrow, A. W. White, Jr., and J. R. Stansell, Tifton.--The striking similarity of data compiled by several methods of estimating evapotranspiration in the summer months of 1957 indicate that quite reliable estimates may be computed from climatic data.

Burley tobacco yields and market value from various irrigation treatments, Groseclose silt loam, Blacksburg, Va., 1954-57

Year and treatment	Water			Yield	Value	
	Rainfall	Irrig.	Total	Per acre	Per acre	Per cwt.
1954						
Irrigation	*Inches*	*Inches*	*Inches*	*Pounds*	*Dollars*	*Dollars*
None	10.0	0	10.0	2,967	1,228	41.40
Knee-high to bloom	10.0	3.5	13.5	3,630	1,609	44.30
Full season	10.0	8.1	18.1	3,699	1,789	48.40
1955						
Irrigation						
None	8.6	0	8.6	2,289	917	40.06
Knee-high to bloom	8.6	3.5	12.1	2,550	1,374	53.88
Full season	8.6	5.5	14.1	2,421	1,304	53.86
1956						
Irrigation						
None	11.2	0	11.2	2,664	1,705	63.95
Knee-high to bloom	11.2	2.0	13.2	2,972	1,954	65.70
Full season	11.2	4.0	15.2	2,787	1,752	62.68
1957						
Irrigation						
None	12.0	0	12.0	2,875	1,767	61.46
Knee-high to bloom	12.0	4.0	16.0	2,973	1,807	60.78
Full season	12.0	4.5	16.5	2,868	1,795	62.59
4-Yr. Average						
Irrigation						
None	10.5	0	10.5	2,699	1,404	51.72
Knee-high to bloom	10.5	3.3	13.7	3,031	1,686	56.17
Full season	10.5	5.5	16.0	2,944	1,660	56.88

In the accompanying table, daily water losses are given for Tifton, Georgia, for the months of May, June, July and August as ascertained by several methods of measurement and estimation. Column 2 is inserted for comparison of the several methods with the measured water surface evaporation from a standard above-ground Weather Bureau evaporating pan. Column 3 lists the estimated potential evapotranspiration by the Penman formula, while Column 4 lists the estimations by the Thornthwaite method. Column 5 lists the evapotranspiration estimated by a method suggested by C. H. M. van Bavel wherein latitude, the time of year and the general observed character of the day only are considered. Column 6 was obtained from data taken experimentally in the measurement of evapotranspiration in connection with irrigation research.

The data recorded in Column 5 were obtained by soil sampling and moisture determinations by gravimetric means. The figures for May and June were results of studies with flue-cured tobacco. July and August were from runner peanut experimentation.

The data suggest that any of the methods of estimation may be within the range of required accuracy for farmer usage in estimating daily loss of soil moisture by evapotranspiration.

Comparison of various means of estimating or measuring water losses by evaporation or evapotranspiration, Tifton, Ga., May-August, 1957

Period	Computed mean daily water losses based on:				
	Surface evaporation	Penman formula	Thornthwaite method	Daily estimation	Field measure
	Inches	*Inches*	*Inches*	*Inches*	*Inches*
May 1-10.....	.14	.10	.11	.14	.16
May 11-20.....	.18	.14	.16	.17	.21
May 21-31.....	.22	.16	.18	.20	.16
May Mean.....	.18	.14	.15	.17	.17
June 1-10.....	.14	.10	.17	.17	.12
June 11-20.....	.23	.21	.21	.21	.18
June 21-30.....	.19	.16	.22	.19	.19
June Mean.....	.19	.16	.20	.19	.17
July 1-10.....	.20	.18	.22	.20	---
July 11-20.....	.17	.13	.21	.17	.14
July 21-31.....	.16	.14	.21	.19	.20
July Mean.....	.18	.15	.21	.19	---
August 1-10.....	.19	.17	.21	.18	.18
August 11-20.....	.22	.14	.21	.20	.19
August 21-31.....	.20	.15	.16	.18	.20
August Mean.....	.20	.15	.19	.19	.19

Georgia

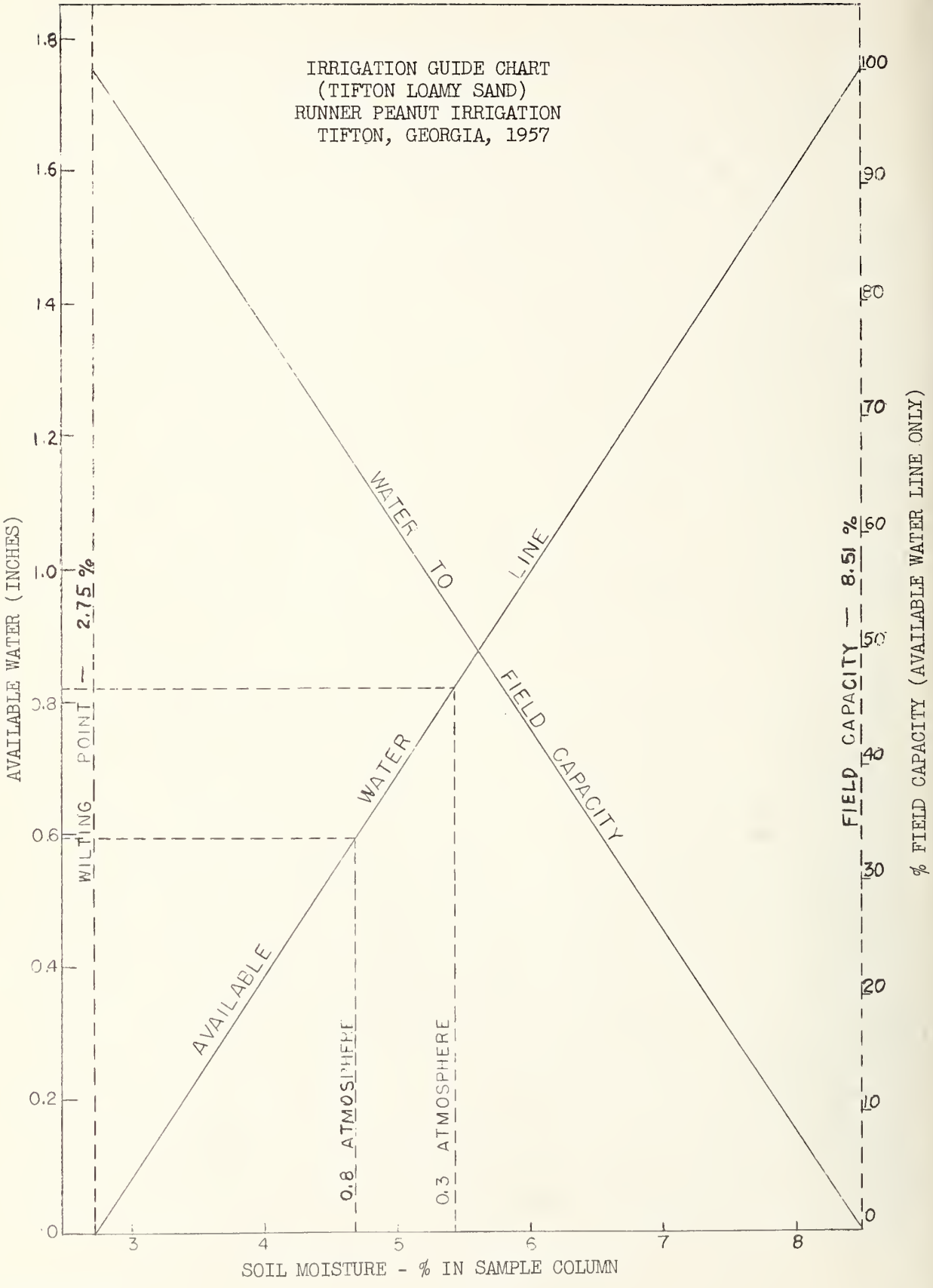
SIMPLE IRRIGATION GUIDE CHART SHOWS SOIL MOISTURE STATUS

G. N. Sparrow, J. R. Stansell, and R. L. Carter, Tifton.--A simple chart has been used as a ready indicator of the status of soil moisture with respect to permanent wilting point and field capacity.

The character of the chart is shown in the accompanying illustration. The percent of soil moisture ascertained by columnar soil sampling is represented along the horizontal axis from 0% to the percentage at field capacity. Soil moisture in terms of inches for the soil column is represented on the left along the vertical axis from zero to the columnar moisture at field capacity. A scale can be set up on the right along the field capacity line to represent the percent of field capacity of any percentage of soil moisture.

If treatment controls in an experiment are based on soil moisture tensions, control points may be established by extracting from the soil moisture release curve the percentage of soil moisture at the respective soil moisture tensions. In the illustration, those points are given as "0.8 atmosphere" and "0.3 atmosphere".

Two diagonal lines are drawn on the chart. The "Available Water Line" is drawn from a point on the horizontal axis representing the percent of soil moisture at permanent wilting point to a point on the "Field Capacity" line equal to the inches of water available to plants at field capacity. A "Water to Field Capacity" line is drawn from a point on the horizontal axis representing the percentage of soil moisture at field capacity to a point on the "Permanent Wilting Point" line equal to the inches of water available to plants at field capacity.


IRRIGATION GUIDE CHART
(TIFTON LOAMY SAND)
RUNNER PEANUT IRRIGATION
TIFTON, GEORGIA, 1957
AVAILABLE WATER (INCHES)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
WILTING POINT — 2.75 %
FIELD CAPACITY — 8.51 %
100
90
80
70
60
50
40
30
20
10
0
% FIELD CAPACITY (AVAILABLE WATER LINE ONLY)
WATER TO LINE
FIELD CAPACITY
AVAILABLE WATER
0.8 ATMOSPHERE
0.3 ATMOSPHERE
3
4
5
6
7
8
SOIL MOISTURE - % IN SAMPLE COLUMN

At any given percent of soil moisture obtained by columnar sampling the point of intersection of a vertical line to the "Available Water Line" will be represented along the left vertical line as the inches of water then available to plants. If the vertical line from the percentage point is drawn until it intersects with the "Water to Field Capacity" line, the point will be represented along the left vertical line by the inches of water required to bring the soil up to field capacity.

Alabama

DECREASING SOIL MOISTURE TENSION INCREASES P CONTENT OF FORAGE

Orus L. Bennett, Thorsby; and Victor J. Kilmer, Donald F. Timmons, Virginia F. Stahly, Beltsville, Maryland. --The phosphorus content of forage crops was found to vary inversely with soil moisture tension in an irrigation study carried out at Thorsby, Alabama.

Cool season forage species were irrigated by an overhead sprinkling system in such a manner as to maintain varying levels of soil moisture throughout the growing season. One series of plots was irrigated when the soil moisture tension in the root zone averaged 10 atmospheres. A second series was irrigated at 4 atmospheres, and a third series at 0.67 atmospheres. Water received by the plots during a 35 day test period (May 1 - June 4) at the above irrigation levels was 2.64, 5.74, and 7.24 inches, respectively. Grasses received 50 pounds of nitrogen per acre after each harvest and all species received 200 pounds 0-12-20 per acre after each harvest. The June 4 harvest, which was used for laboratory studies, was the third harvest for the 1956 season and represents a period when irrigation effects were considered to be at a maximum. Data for the growing period of May 1 to June 4 are given in the table.

Phosphorus content of various plants produced at different soil moisture tensions, Thorsby, Ala., 1956

Soil moisture tension	Plant phosphorus						
	Fescue	Atlantic alfalfa	Red clover	Reed canary	Orchard grass	White clover	Ladino clover
Atmosphere	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
10.....	0.26	0.22	0.25	0.25	0.25	0.26	0.26
4.....	.32	.26	.29	.30	.32	.29	.33
0.67.....	.34	.28	.31	.32	.32	.30	.33

Higher concentrations of plant phosphorus, as well as increased yields of forage were obtained at the lower soil moisture tension levels.

Studies of other plant nutrients are currently underway in order to determine if the effects described are limited to phosphorus or whether other ions may also be affected. This study indicates that the results of short term fertilizer experiments where soil moisture is uncontrolled should be interpreted with caution, since soil moisture stress may markedly influence the rate at which soil phosphorus is taken up by the plant.

California

WELLS APPEAR FEASIBLE FOR DRAINAGE IN THE SAN LUIS SCD

Leonard Schiff, Bakersfield.--This field study has been reported in Quarterly Progress Reports No. 11 and No. 13. A final report has been prepared. The investigation shows that, in general, wells appear feasible for lowering the ground water table because of the characteristics of the soil and stratigraphy. The water table is continuous, and shallow soils of low hydraulic conductivity are underlain by deep soils of high hydraulic conductivity. Soil layers of low hydraulic conductivity at various depths are discontinuous.

In some portions of the District, however, wells were not found as effective in lowering the ground water table as in other locations because of seepage from canals or ditches. Generally, drainage wells should not be placed near canals which seep appreciably unless such canals are treated or lined to reduce seepage.

California

BASINS MAY CONTRIBUTE TO DRAINAGE WATER DISPOSAL

Leonard Schiff, Bakersfield.--A report entitled, The Feasibility of Disposing of Drainage Effluent in Basins, was prepared for the Tulare Lake SCD by Leonard Schiff, Carl H. Anderson, Jr., and Donald E. Foote. The investigation shows that the size of a basin required for the disposal of the drainage yield from 270,000 acres varies from 5 to 10 square miles for the initial and ultimate yields, respectively. The basin or service area for the ultimate yield is 2.4 percent of the agricultural area drained.

Disposal processes considered are evaporation, percolation, and lateral flow. Only a small amount of lateral flow will occur. This flow may be intercepted and returned to the disposal basin, if desired. After initial percolation to fill voids from the soil surface to the salty water table 9 feet below, little percolation will occur. At this location, most disposal will take place by evaporation and little or no contamination of surrounding areas will occur.

Ponding to a depth of about three feet is desirable for mosquito abatement and the development of a habitat for fowl and game. Regulation of irrigation and depths on portions may permit a cash return from salt-tolerant vegetation. Transpiration from volunteer or planted vegetation as a disposal process was not considered.

California

LIMITED USE OF INTERCEPTORS NEEDED IN THE FIREBAUGH SCD

Leonard Schiff, Bakersfield.--A report of this field study entitled, The Feasibility of Using Interceptors Based on Seepage Volume, has been prepared by Leonard Schiff and Gene H. Novak. It was pointed out that the present flow of the perched ground water throughout the District does not appear to warrant an interceptor across the entire District. Quantities of seepage from relatively short reaches of canals may warrant short interceptors or soil treatments or lining canals along certain reaches.

Increase in upslope irrigation will increase seepage into the District and may ultimately warrant an interceptor throughout the District.

Wet spots or mounds near the soil surface are caused by tail-water, tail-water ponding, tail-water ditches, or rice irrigation. These spots are locally detrimental but have little effect on the ground-water table over the District as a whole. Tail-water ditches,

where not located in soils or low hydraulic conductivity, should be soil-treated, deepened, or lined to reduce leakage.

Solutions to drainage problems in the District appear to include tile placed in the most permeable soil layers at the greatest depth practicable, relatively short interceptors at strategic locations, and careful selection of routes for conveyance ditches. Determination of hydraulic conductivities and hydraulic gradients for the major soil layers will do much to "get the most drainage for the investment."

North Dakota

RED RIVER VALLEY WATER TABLES ARE AFFECTED BY RAINFALL

Leo C. Benz, Rome H. Mickelson, Fred M. Sandoval, Jr., and Carl W. Carlson, Mandan and Grand Forks.--Drainage studies in a saline area of the Red River Valley in Grand Forks County, North Dakota, indicate that rainfall is the major source of water causing the existing high water table problems. Artesian pressure exists at depth throughout the area and flowing and nonflowing wells are numerous, however, the quantity of water moving upward from the artesian aquifer and contributing to the water table appears to be small in relation to the contribution by rainfall. Surface drainage is poor in the study area with the ground surface slope averaging about 2-1/2 feet per mile. A network of observation wells and piezometers has been installed to study ground water movement, elevations, and trends.

Data from a typical piezometer cluster installed to investigate artesian pressures are plotted in figure 1. The 58-foot piezometer was terminated in clay and required about 1 month after installation to come into equilibrium. The 38-foot piezometer was terminated in extremely "tight" clay and required almost 3 months after installation to come into equilibrium. Neither of these piezometers was affected by rainfall. The hydraulic gradient between the 58- and 38-foot piezometers, following their coming into equilibrium with pressures in the soil, indicates upward movement of water. The pressure differential of slightly more than 1 foot is not, however, sufficiently great to cause appreciable quantitative flow through the 20-foot layer of highly impermeable soil involved. This premise is supported by the fact that the 18-foot piezometer recorded the same water level as that in an open observation well at the same location and was markedly affected by rainfall.

Observation wells installed to study fluctuations and trends of water table movement indicate that the higher water table elevations are closely associated with high rainfall. This is shown for a typical observation well by the data presented in figure 2. Good surface drainage would reduce penetration of rainfall during the heavier storms and would undoubtedly aid in reducing the high water table problem in some areas. Surface drainage alone would not correct some of the existing salinity problems. Satisfactory solutions to the overall problem will undoubtedly require a combination of land treatment, surface drainage, and ground water drainage. The present investigation is aimed at the development of satisfactory methods and practices for solving the overall problem.

Georgia

DEEP DITCHES PROVIDE NEGLIGIBLE DRAINAGE ON BLADEN SOIL

R. L. Green, J. M. Daniels, Fleming.--Deep ditches provide negligible subsurface drainage in Bladen fine sandy loam at Fleming. The deep drainage ditch caused lowered forage yields and lowered water-tables immediately adjacent to the ditch. No significant difference in forage yields occurred more than six feet from the ditch, and beyond twelve feet there was no effect on ground water profiles.

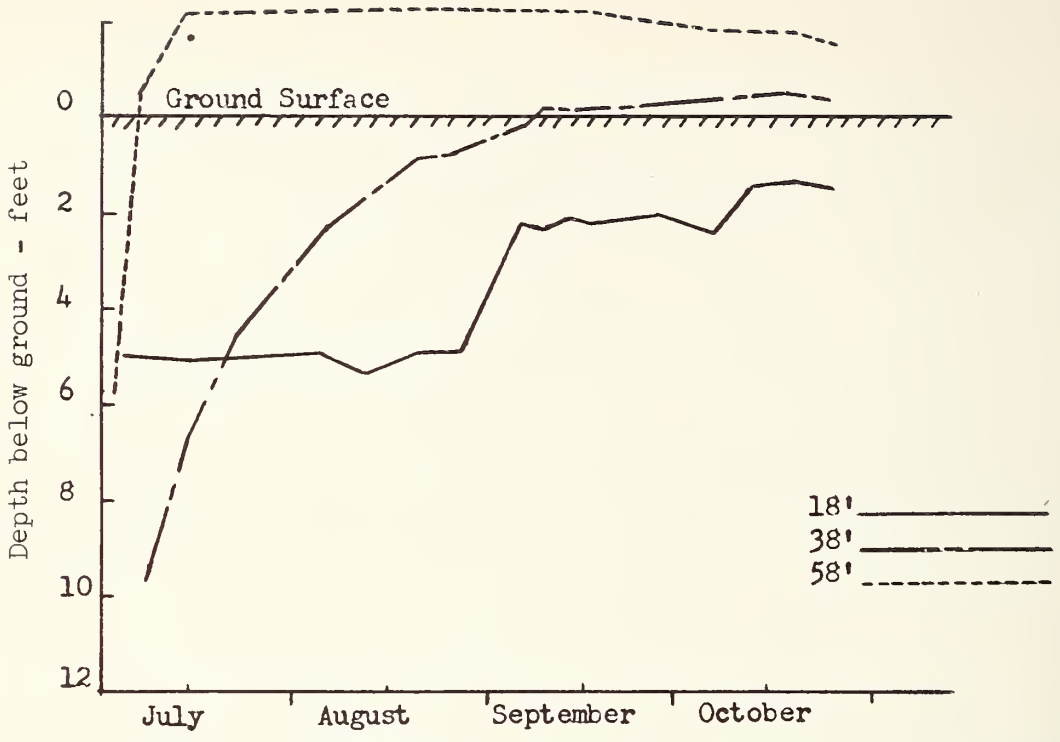


Figure 1.--Hydraulic heads of a piezometer battery with piezometers terminated at depths of 18', 38', and 58' below the ground surface, Grand Forks, N. Dak., 1957.

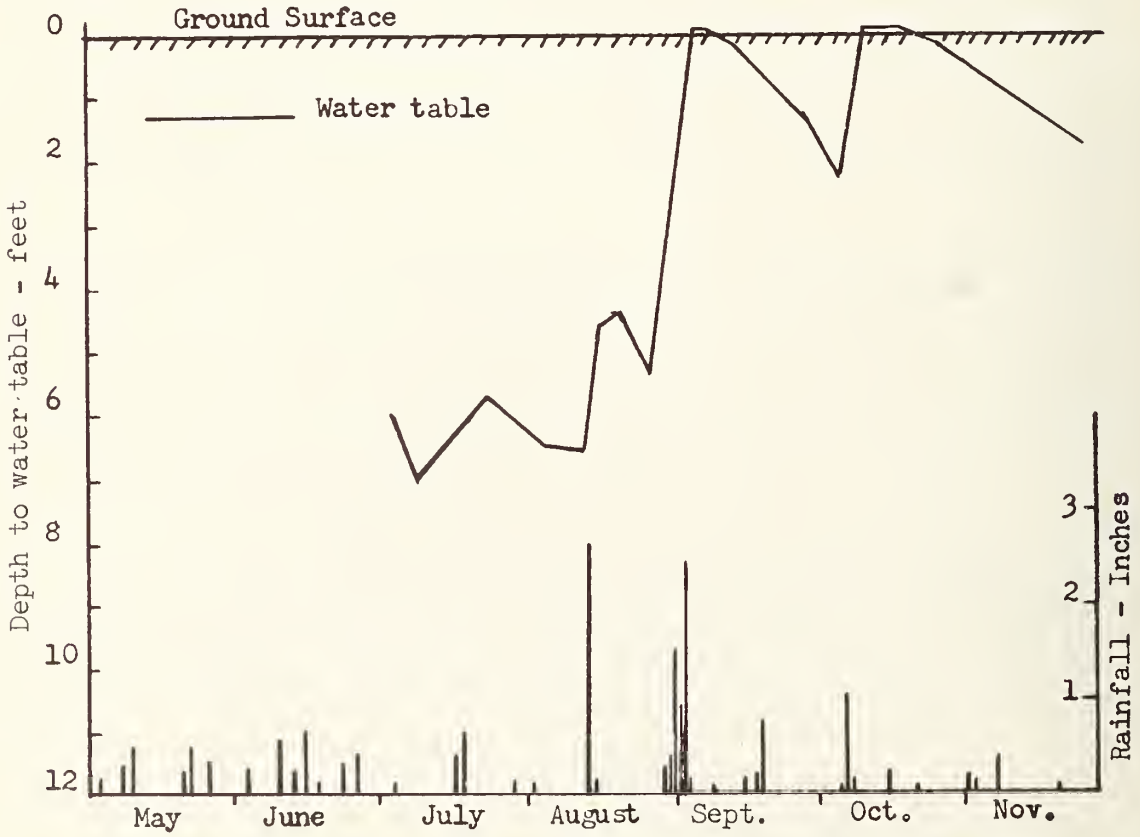


Figure 2.--Fluctuations of the water table in a 12' deep observation well and 1957 rainfall, Grand Forks, N. Dak., 1957.

As shown in the table, forage yields of Argentine Bahia grass with crimson and ladino clovers increased with distance from the ditch up to distances of twenty feet. However, the increase in yield was of no statistical significance except within six feet of the ditch. The decline in mean forage yields for the three years may be attributed to a difference in the crimson clover crops of the three years. Winter and spring 1954-55 were favorable for crimson clover, 1955-56 was less favorable, and the winter of 1956-57 was so dry that crimson clover was a complete failure.

Yields of Argentine Bahia grass with clover at various distances from ditch with five foot depth, Fleming, Ga., 1955-57

Distance from ditch	Forage yield per acre - 16% Moisture			
	1955	1956	1957	Mean
Feet	*Tons*	*Tons*	*Tons*	*Tons*
2	3.61	2.12	2.92	2.88
6	4.84	3.06	2.98	3.63
12	4.72	3.44	3.15	3.77
20	5.14	3.68	3.36	4.06
30	5.11	3.66	3.01	3.93
42	4.64	3.73	3.20	3.86
67	4.42	3.19	2.98	3.53
92	3.71	3.07	2.92	3.23
117	4.72	3.21	3.17	3.70
142	4.78	3.36	3.25	3.80
Mean	4.57	3.25	3.09	3.64

From these data it may be concluded that ditches will provide negligible subsurface drainage in Bladen soil. Obvious secondary conclusions are that: (1) drainage ditches should be cut in Bladen soil only for outlet channels, (2) drainage of Bladen soil must be accomplished by land smoothing, land forming, or other surface drainage methods.

EROSION AND RUNOFF CONTROL

Kansas

STRIP WIDTH FOR EROSION CONTROL RELATED TO TEXTURE

W. S. Chepil, Manhattan.--The item under this title in Quarterly Progress Report No. 12 contained an error in next to the last paragraph on page 8. This paragraph should have read as follows:

Finally, and probably the most important factor that determines how wide the strips should be on different soil textures is the amount of crop residue anchored at the surface. The required width of strips varies in direct proportion with the amount of crop residue. For example, if the amount of crop residue is doubled, soil erodibility is roughly reduced to half so that width of strips may be doubled for equal effectiveness.

MULCH COVER IS BEST RUNOFF AND EROSION CONTROL PRACTICE

Loy M. Naffziger and Glenn M. Horner, Pullman. --Runoff and soil loss measurements during the 1957-58 winter season showed that a cloddy condition produced by certain tillage operations was an effective erosion control practice when applied to sweetclover-green manure land seeded to winter wheat in the high rainfall section of the Palouse region.

The following tillage treatments were used:

1. Early plowing: Sweetclover-green manure land was moldboard plowed in early June, harrowed immediately, and cultivated six times during the summer.

2. Late plowing: The land was moldboard plowed on July 11 with the sweetclover at the full-bloom stage. No other tillage operation was performed prior to seeding winter wheat.

3. Subsurface tillage (mulch): The sweetclover topgrowth was clipped in early June. The land was subtilled with a large sweep when the sweetclover regrowth reached the full-bloom stage. A subsurface weeding operation was made prior to seeding winter wheat.

Average runoff and erosion for three replications are summarized here. The data are tabulated separately for the first and last portions of the winter season, in order to show the relative length of time that effective erosion control was maintained by each treatment.

Tillage treatment	Runoff and erosion per acre			
	Dec. 19, 1957 - Feb. 9, 1958		Feb. 12-24, 1958	
	Runoff	Erosion	Runoff	Erosion
	Inches	*Tons*	*Inches*	*Tons*
Plowed early	0.10	0.5	0.09	0.4
Plowed late	0.003	0.01	0.20	0.5
Subsurface tilled	0.000	0.00	0.00	0.0

Runoff began in December on the early-plowed land. This treatment caused a greater degree of pulverization of the soil and a more rapid puddling of the surface.

Late plowing prevented runoff during four storm periods in December, January, and February when runoff occurred on the early-plowed land. The cloddiness caused by the late plowing remained effective until a major storm occurred on February 12 and 13. This storm, plus a series of subsequent storms, caused the clods to break down and the surface of the soil to become puddled.

Subsurface tillage, with a minimum of cultivation for weeds, resulted in no runoff during the entire season. The mulch cover kept the surface from becoming excessively puddled.

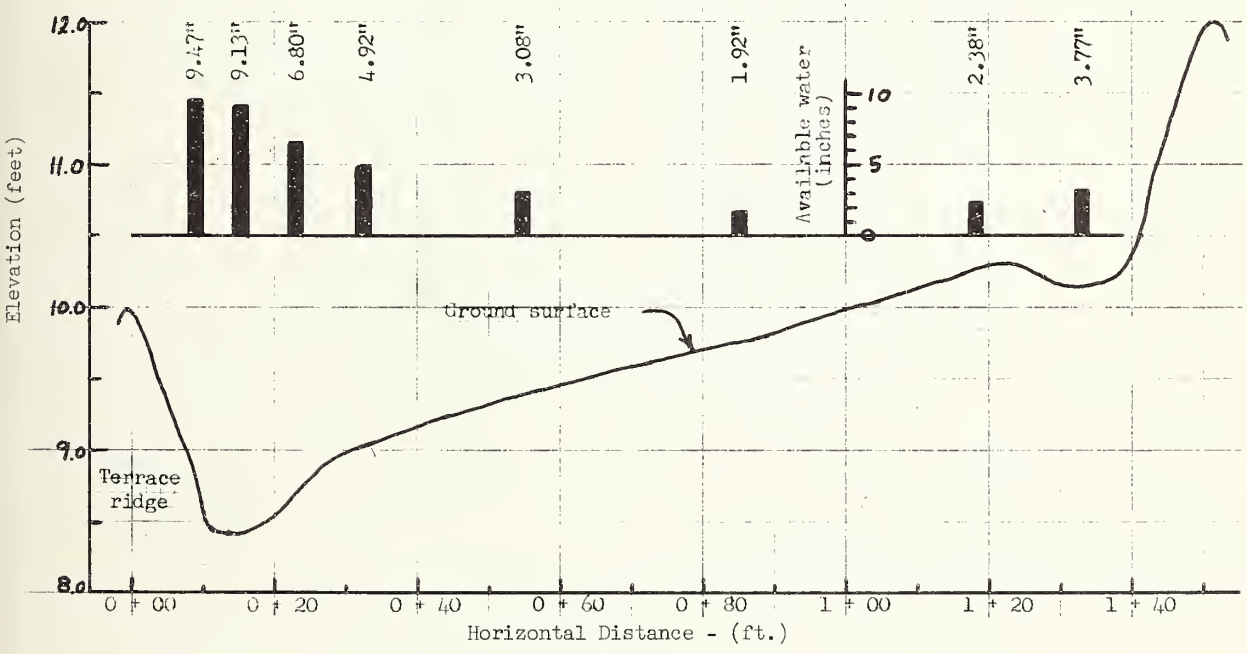
These results indicate that a cloddy condition may not remain effective for runoff and erosion control throughout the winter season. A mulch cover produced by subsurface tillage results in a longer lasting protection against runoff, especially if combined with at least a moderate degree of cloddiness.

Texas

SOIL MOISTURE DISTRIBUTION MEASURED ON TERRACED HARDLANDS

Victor L. Hauser, Bushland. --Level closed end terraces have been used for several years in the Southern High Plains to control runoff water on hardlands. Terraces have been found objectionable by farmers because of ponding of water in the terrace channels and subsequent drowning of crops. Tillage is also often delayed by wet soil in terrace channels.

Soil moisture samples were taken in a fallow field with a level closed end terrace system to determine the moisture distribution in the soil. Two cross sections were sampled and the average values for soil surface elevation and available soil moisture are shown in the accompanying figure. A total of 10.43 inches of rain fell on the area in the 4 months preceding the sampling date.



Relationship between ground surface elevation and soil moisture storage on level terraced land under fallow, Bushland, Tex., July 2, 1957.

Level terraced land has produced small increases in yield over unterraced land, yet most of the surface runoff was held on the terraced fields by the terrace ridges. Apparently, level terraces on hardlands have not produced effective use of runoff water.

Based on the amount of available water stored in the soil, the channel and terrace interval should be managed differently for maximum production, but this is often difficult on conventional terrace systems. An increase in yield in the terrace channel does little to raise the average yield for the whole field due to the small area involved.

Iowa

CONTOUR LISTING IS EFFECTIVE IN REDUCING EROSION

W. C. Moldenhauer, Ames.--Crop rotation and tillage methods during the past 10 years have had a marked influence on soil and water loss on a 12 percent Ida silt loam soil at the Western Iowa Experimental Farm near Castana. Treatments consisted of a corn-oats rotation with sweetclover as a green manure crop and a corn-oats-meadow-meadow rotation. In the corn-oats rotation corn was contour listed, contour surface planted, and surface planted up-and-down hill. In the corn-oats-meadow-meadow rotation, corn was contour listed. The plots were 0.175 acre in size, and thus had to be hand tilled to simulate field operations as closely as possible.

Contour listing proved very effective in reducing erosion losses. In the corn-oats (sweetclover) rotation the average annual soil loss from listed corn was approximately one-half that from contour surface planted corn and one-fifth that from up-and-down hill planted corn (table 1). Inclusion of meadow in the rotation reduced soil loss still more. Water losses were reduced similarly, although the reductions from contouring and listing were not so large. Annual soil and water losses under oats were comparable following all corn tillage methods. Water losses were somewhat lower from oats in the corn-oats-meadow-meadow rotation. Soil losses under meadow were negligible, but average annual water losses were one-half of three-quarters of an inch even under brome-alfalfa meadow.

TABLE 1.--Soil and water loss as affected by cropping and tillage practice on Ida silt loam, 12 percent slope, Castana, Ia., 1948-57

Rotation and tillage method	1948-57 average erosion and runoff	
	Soil loss per acre	Runoff
Corn		
Corn-oats (sweetclover)	*Tons*	*Inches*
Up-and-down hill surface planted	25.2	3.23
Contour surface planted	10.1	2.08
Contour listed	4.9	1.44
Corn-oats-meadow-meadow		
Contour listed	1.3	0.57
Oats		
Corn-oats (sweetclover)		
Corn up-and-down hill surface planted	2.7	1.80
Corn contour surface planted	2.4	1.95
Corn contour listed	3.0	2.00
Corn-oats-meadow-meadow	2.7	1.08
Alfalfa-brome		
Corn-oats-meadow-meadow		
First year meadow	0.2	.78
Second year meadow	0	.54

The effectiveness of contour listing in controlling soil and water losses is due to surface detention of water before the ridges and furrows are destroyed by cultivation. Consequently, after the last cultivation which occurs during late June or early July, losses of soil and water are very similar to those under contour surface planting. June is the month of greatest erosion under contour planting, and protection during this period

is highly important as shown in figures 1 and 2. Over 60 percent of the soil loss from contour surface planted corn occurred before the last cultivation while only about 10 percent of the soil loss from contour listing occurred during the same period as shown in table 2.

In addition to its obvious significance in runoff and erosion control, these data show the possibility for increasing terrace spacing when good management practices are used. The effectiveness of contour listing in conjunction with a corn-oats-meadow-meadow rotation has been shown on a field scale. Work is underway to determine the effect on a field scale in a corn-oats rotation.

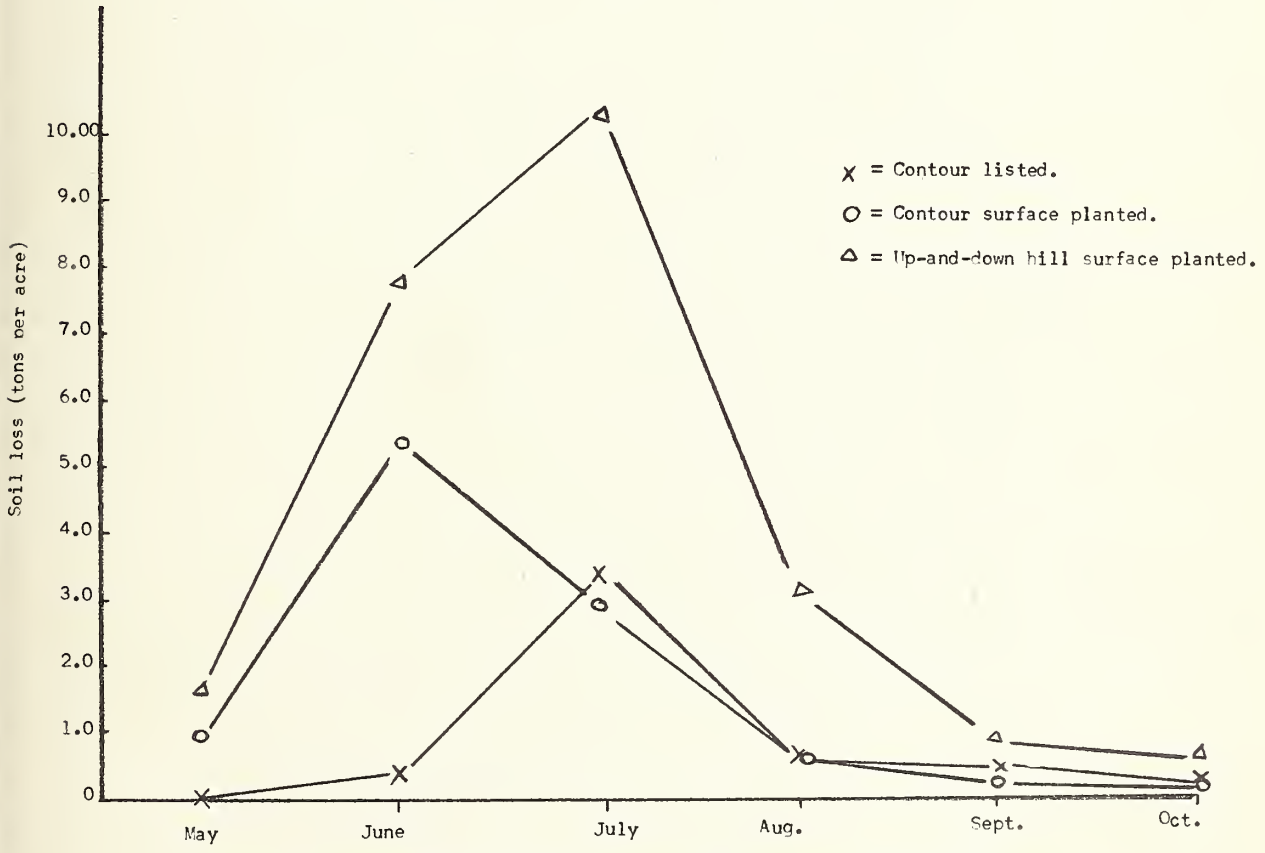


Figure 1.--Average annual soil losses by months on Ida silt loam, Castana, Ia., 1948-57.

Figure 2.--Average annual runoff under corn by months on Ida silt loam, Castana, Ia., 1948-57.

TABLE 2.--Average soil and water losses before and after last cultivation on Ida silt loam, Castana, Ia., 1948-57

Period	Erosion and runoff from corn		
	Contour listed	Contour surface planted	Up-and-down hill surface planted
	Soil loss (Tons per acre)		
Before last cultivation.....	0.55	6.58	10.56
After last cultivation.....	4.26	3.54	13.73
Average annual soil loss.....	4.81	10.12	24.29
	Water loss (Inches)		
Before last cultivation.....	0.22	.91	1.05
After last cultivation.....	1.10	1.11	2.03
Average annual runoff.....	1.32	2.02	3.08

Mississippi

SOIL LOSS FROM SEEDING IN SOD IS NOT EXCESSIVE

C. K. Mutchler, State College.--Seeding oats in permanent pasture sod to increase winter grazing had no appreciable effect upon either runoff or soil erosion. In this case, seeding was accomplished by cutting narrow slits in the sod and placing seed and fertilizer in the breaks formed in the sod.

Plots, 18 feet wide and 38 feet long, were established in 1956 on Yonaba clay with 9 to 12 percent slope. Common Bermuda grass predominates the permanent pasture cover.

Soil and water losses are shown below:

Time period	Treatments	Soil loss per acre	Runoff
		Tons	*Inches*
November to March	Sod-seeded	.30	5.3
	Sod-check	.29	5.2
April to October	Sod-seeded	.21	2.2
	Sod-check	.12	2.1

The data indicate that sod-seeding may be used on pasture land without risk of incurring harmful erosion and affecting runoff.

Indiana

NEW RAINFALL EROSION INDEX BEING DEVELOPED

W. H. Wischmeier, Lafayette.--A rainfall erosion index has been developed which measures the capacity of a rainstorm or a seasonal rainfall pattern to erode soil from a fallow area or field. Individual-storm rainfall amount and intensity records over a time period of sufficient length to establish normal rainfall patterns provide the information needed to evaluate the index for a particular location.

The large volume of basic data assembled at Lafayette by the Eastern Soil and Water Management Branch, SWC, ARS, from 35 soil and water management research projects east of the Rockies contains individual-storm precipitation and erosion data from continuous row crop or continuous fallow at many locations. Extensive exploratory machine analyses of these data were made to determine the characteristics of rainstorms which are most highly correlated with soil losses. The analyses pointed out that when effects of factors other than rainfall are held constant, the capacity of a specific rain to erode soil from a field depends primarily upon the manner in which the total rainfall energy and maximum prolonged intensity of the storm are combined.

The most precise rainfall erosion index found in the studies was the product of total rainfall energy and maximum 30-minute intensity of the storm. Values of this index explain from 72 to 97 percent of the variations in soil loss for individual storms within 7 sets of fallow-plot data. The data represent moderately eroded Shelby, Fayette, Muskingum, and Cecil soils and mechanically desurfaced Shelby and Marshall soils.

Further studies showed that individual-storm index values may be combined to obtain a seasonal or annual rainfall index closely correlated with total soil losses over time periods involving relatively constant surface conditions. Such seasonal erosion indices

computed from records ranging from 10 to 22 years in duration explain from 72 to 96 percent of the yearly variation in the seasonal soil loss totals for continuous row crop or fallow in studies at Bethany and McCredie, Missouri; Clarinda, Iowa; Watkinsville, Georgia; and Guthrie, Oklahoma.

It was also found that the distribution of the rainfall erosion potential within the year as related to changes in field surface conditions associated with cultural operations and stages of vegetal growth affected average annual soil losses.

The rainfall erosion indices alone did not provide estimates of specific-year soil losses. Also, for short time intervals, variations in associated factors caused rather large bias in some cases. However, over a period of many years, the effects of these variations tended to balance so that estimates of average erosion losses for the longer time periods were sufficiently accurate to serve as a basis for sound conservation farm planning.

Index values and seasonal distributions of erosion potential normally expected in the various sections of the agricultural areas of the United States are now being evaluated from Weather Bureau records to provide the basic components of a universal erosion equation. Cropping, soil treatment, and management factors for this equation are being evaluated from the assembled plot data on a seasonal basis. This approach will facilitate full use of all available research information for estimating average soil losses associated with the various combinations of soil, slope, cropping, and management practices in specific localities including those not directly covered by research studies.

SOIL FERTILITY

Pennsylvania

POOR YIELDS ON ACID SUBSOILS MAY BE DUE TO ALUMINUM TOXICITY

W. V. Chandler, University Park. --Low yield of crops grown on soils with acid subsoils may be caused by aluminum toxicity in the subsoil. Sudangrass grown on an Allenwood subsoil in the greenhouse produced only 0.21 grams per pot with a complete fertilizer treatment. The yield increased to 13.12 grams when the pH was raised from 4.8 to 5.6 with lime. The Sudangrass roots in the low pH soil showed very marked symptoms of aluminum toxicity. Different species of crops apparently respond differently to levels of aluminum.

The same symptoms were produced on Sudangrass in sand cultures by increasing the aluminum content of the nutrient cultures but not by increasing manganese content. The yields were depressed as the aluminum content was increased above 5 ppm. aluminum in solution. The yields were 1.25, 1.25, 1.00, 0.82, and 0.66 grams for solutions containing 1, 5, 10, 15 and 22 ppm. aluminum, respectively.

The aluminum in the soil solution actually tested 2 ppm. Although this level of aluminum was not toxic in the nutrient solution, the concentration of all other nutrient ions was much higher in nutrient solution than in the soil solution. This may have had a mitigating effect. Raising the pH of the soil from 4.8 to 5.6 apparently inactivates sufficient of the aluminum to reduce the toxic effects.

Maryland

CERTAIN BACTERIA INDUCE CHLOROSIS IN SOYBEANS

Lewis W. Erdman, Herbert W. Johnson, and Ura Mae Means, Beltsville. --
It has been proved that certain bacteria are capable of inducing chlorosis in a number of soybean varieties. Intensive research on this problem has shown that the severity of chlorosis, ranging from light green to nearly white leaves, is associated with (1) light intensity, (2) substrate in which the plants are grown, and (3) the nutrition of the plant.

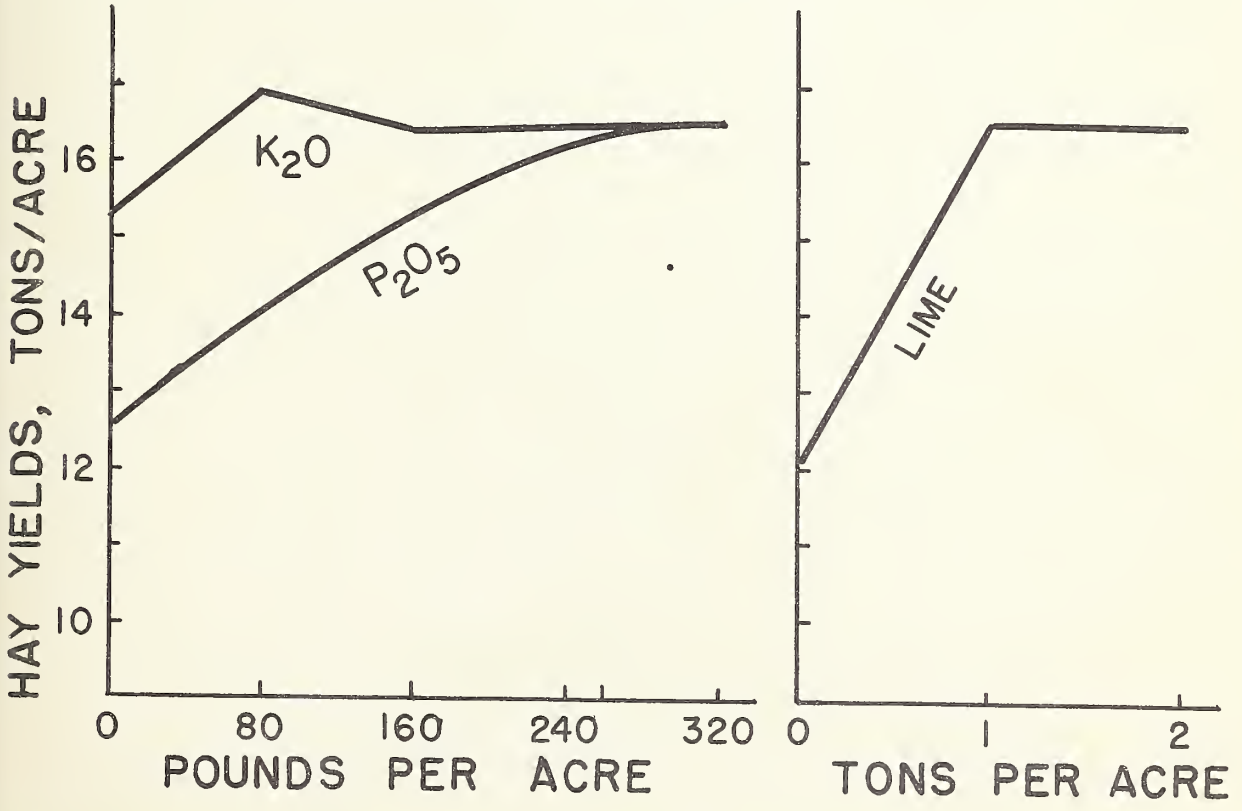
Cell-free extracts made from nodules on chlorotic plants produce chlorosis in seedlings of sorghum, sesame, onions, crabgrass, rice, and tomatoes. This chlorosis-producing substance is not destroyed by freezing, drying, or autoclaving at 121° C. Experiments have shown that there is an interaction between different chlorosis-inducing strains of bacteria and soybean varieties. Some strains produce chlorosis on Lee but not on Hawkeye; some affect Hawkeye and not Lee. Other strains will produce chlorosis on both these varieties. Still others will not work on either of these varieties but will affect others. The chlorosis-inducing factor is rather widespread in the field, having been found in California, North Carolina, Mississippi, Indiana, and Ohio. In most cases, soybeans will recover from this chlorosis within two or three weeks although it was shown that yields may be considerably lower than when soybeans are inoculated with known nonchlorotic producing strains of soybean bacteria. The actual economic effect of this chlorotic condition on the soybean industry remains to be determined and further research is under way to isolate the compound or factor that causes this chlorosis.

South Carolina

SERICEA RESPONDS WELL TO LIME AND PHOSPHORUS

E. H. Stewart, Clemson. --Both lime and phosphorus are needed for maximum yields of sericea lespedeza in the Piedmont, in spite of the fact that sericea is generally considered to be a crop that can make satisfactory growth at low fertility levels.

A lime and fertilizer rates test was established in 1950 on a Cecil sandy loam that had not been cropped or fertilized for at least 12 years. The soil was moderately acid (pH 5.5) and at a low fertility level. Sericea lespedeza was grown at three levels of dolomitic lime, 0, 1, and 2 tons per acre and 4 levels of P_2O_5 and K_2O, respectively, 0, 40, 80, and 160 pounds per acre. Repeat applications of P_2O_5 and K_2O were made as top-dressings in the summer of 1954. The yield responses to these treatments are shown graphically in the accompanying figure for the period 1950-57.



Seven year total yield of sericea lespedeza hay as affected by rate of lime, superphosphate and muriate of potash applications, Clemson, S. C., 1951-57.

One ton of lime increased the yield 27 percent which amounted to 4.5 tons per acre of hay for the 7-year period. During the latter part of the period, yield increases for the second ton of lime were just becoming evident. The pH of the soils in 1957 was 5.1, 5.6 and 6.1, respectively, for the 0, 1 and 2 ton lime applications made in 1950.

Each of the first two increments of 80 pounds per acre of P_2O_5 produced yield increases of 1.4 tons per acre of hay. The next 160-pound rate of P_2O_5 produced hay yield increases of 1.4 tons per acre. The next 160-pound rate of P_2O_5 increased yields equivalent to the first 80-pound increment, indicating a leveling off of yield response.

Potash requirements of this crop appear to be somewhat lower on this soil than it is for such crops as alfalfa and white clover. However, a yield response to potash fertilization was obtained in this experiment after 5 years of cropping. The crop removed only about 15 to 20 pounds of potassium per ton of hay.

Georgia

SPRING BETTER THAN FALL TO APPLY N FOR CORN

William E. Adams, Watkinsville. --Nitrogen applied to corn at planting on Cecil sandy loam soil in the spring was much more effective than the same source and rate of nitrogen applied the previous fall.

The yield response of corn to nitrogen applied in the spring as ammonium nitrate is shown on the graph by the solid line. The yields produced by 30 and by 90 pounds of ammonium nitrate applied the preceding fall are shown on the same graph by the two points connected with a broken line. The distance between the two lines provides a measure of the loss in effectiveness of the fertilizer from fall applications. Thus, 30 pounds of N applied in the fall produced 60 bushels of corn, a yield which, as can be seen from the response curve, would have been made by about 18 pounds of N applied in the spring. Similarly, 90 pounds of fall-applied N made no more corn than 38 pounds applied in the spring.

Expressing these results another way, in 1955-56, fall applied nitrogen was only about one-half as effective as spring applied material, pound for pound of nitrogen.

Georgia

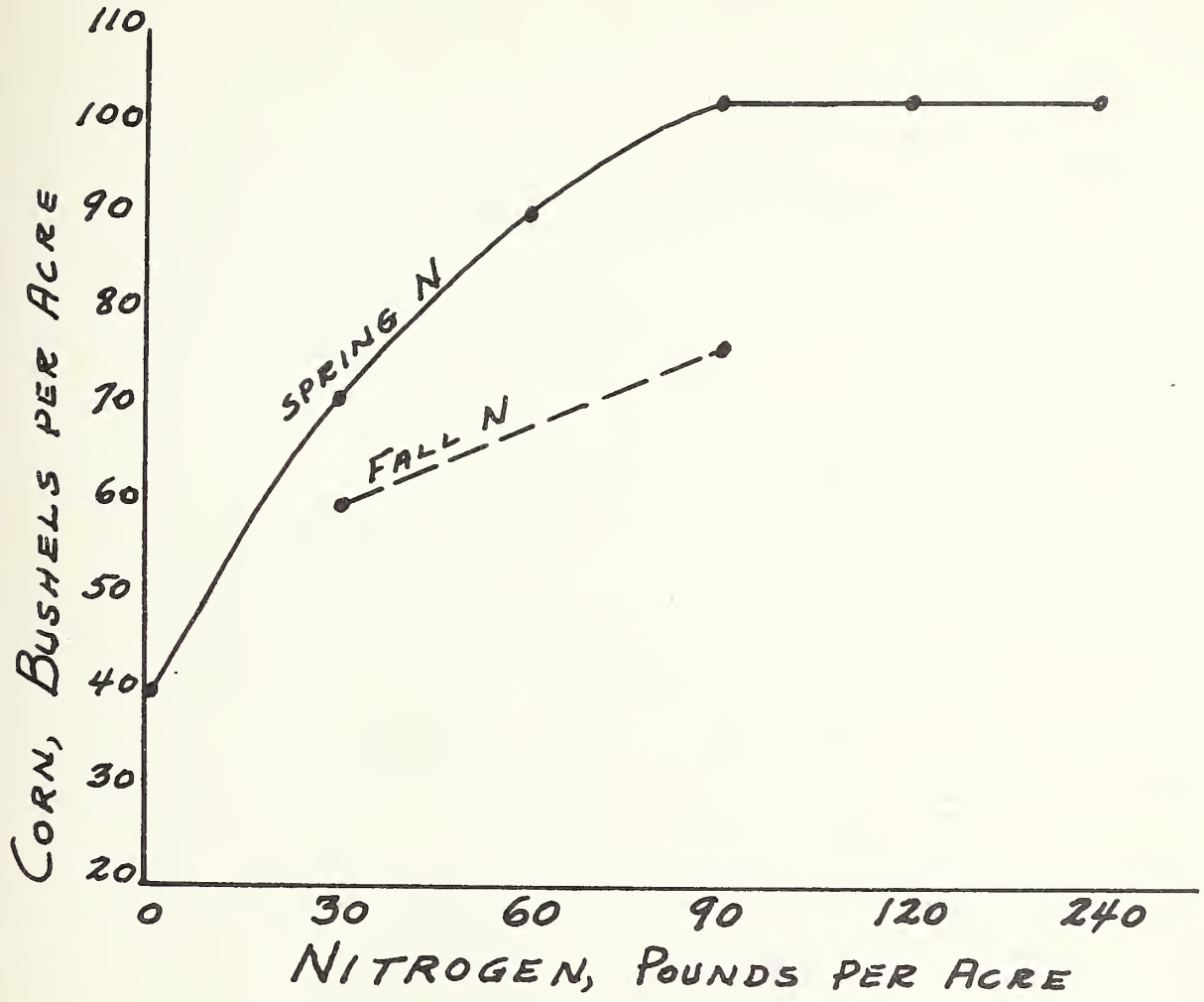
HIGH NITROGEN RATES AFFECT CHEMICAL SOIL PROPERTIES

Charles B. Elkins, Watkinsville. --Studies of Cecil sandy loam soil samples taken from selected treatments of a Coastal Bermuda experiment indicate that soil reaction, total base status, and exchangeable potassium content of the soil may be affected to a considerable depth in the soil profile, when high rates of nitrogen fertilizer are used.

The data in the table show that there was a marked depression of pH, exchangeable bases, and exchangeable potassium in the surface 6-inch layer at the higher rates of nitrogen. There was little effect on pH and exchangeable bases in the 6- to 12- and 12- to 18-inch depth intervals, although there was a tendency for both the pH and exchangeable bases to be lower at the highest nitrogen level. The pH and exchangeable bases follow very closely the same trend throughout the sampled portion of the profile.

Exchangeable potassium was reduced considerably in the deeper soil horizons, even though pH and total exchangeable bases were not affected to any great extent. This reduction of potassium is primarily a result of the very large increase in potassium uptake by Coastal Bermuda at the higher nitrogen rates due to increases in yield.

These studies indicate that the pH and exchangeable potassium of a soil such as Cecil may be reduced to a critical level in a relatively short period of time, when high rates of nitrogen are used.



Effect of fall and spring applied nitrogen on corn production in 1956, Watkinsville, Ga.

Effect on soil reaction, base status, and exchangeable potassium by varying rates of nitrogen on Coastal Bermuda grass grown on Cecil sandy loam soil, Watkinsville, Ga.

N* per acre	0-6 inch depth			6-12 inch depth			12-18 inch depth		
	Reaction	Total exch. bases	Exch. potassium	Reaction	Total exch. bases	Exch. potassium	Reaction	Total exch. bases	Exch. potassium
Pounds	*pH*	*me/100g.*	*Lbs/ac.*	*pH*	*me/100g.*	*Lbs/ac.*	*pH*	*me/100g.*	*Lbs/ac.*
0	5.7	1.78	139	5.3	1.03	105	5.5	1.24	49
237	5.7	1.72	100	5.4	1.20	59	5.5	1.22	21
475	5.5	1.55	65	5.5	1.53	40	5.6	1.45	19
950	4.9	0.91	60	5.1	0.97	64	5.3	1.06	22

*As ammonium nitrate applied over a 2-1/2 year period. 200 lbs. each P_2O_5 and K_2O were applied annually.

Experiments have been planned to make further studies of the effects of high nitrogen rates on soil properties and to develop management practices to both prevent the occurrence of these undesirable changes in the soil profile and to correct them after they do occur.

Georgia

COASTAL OUTYIELDS COMMON BERMUDA OVER WIDE RANGE OF FERTILITY

William E. Adams, Watkinsville. --Coastal Bermuda consistently produced more forage than common Bermuda either with or without crimson clover regardless of the level of soil fertility. The yield difference in favor of Coastal, however, became greater as the level of fertility was increased. Yield data supporting these conclusions are given in the accompanying table.

Yield of Coastal Bermuda and common Bermuda grown with and without crimson clover at different fertility levels on a Cecil sandy loam, Watkinsville, Ga., 1957

Treatments	Yield of Bermuda grass per acre			
	Coastal Bermuda		Common Bermuda	
N - P_2O_5 - K_2O per acre	No clover	With clover (grass only)	No clover	With clover (grass only)
Pounds	*Tons*	*Tons*	*Tons*	*Tons*
0 - 0 - 0	0.97	1.78	0.62	0.96
100 - 50 - 50	3.68	4.38	2.06	2.46
200 - 50 - 50	5.92	5.34	3.38	3.34
200 - 100 - 100	5.97	6.15	3.84	3.60
400 - 100 - 100	7.61	7.03	5.05	4.32
400 - 200 - 200	8.19	7.84	5.34	4.53

Crimson clover increased the forage production of Coastal Bermuda about .70 tons per acre with less than 200 pounds of N. At the 400-N level, the crimson clover had no effect on Coastal's forage production. Crimson clover had a similar effect on common Bermuda.

When Coastal and common Bermuda were grown in association with crimson clover, Coastal was at least 60 percent better than common at all fertilizer levels. At the 200-100-100, and 400-200-200 fertilizer levels, the increase over common was 70 percent or more. Coastal without crimson clover was at least 50 percent better than common.

Crimson clover supplied about 1.0 tons per acre of forage and could have extended the grazing period from 4 to 6 weeks over either grass without crimson clover.

Georgia

SULPHUR-FREE FERTILIZERS MAY LIMIT PIEDMONT COTTON PRODUCTION

William E. Adams, Watkinsville. --The use of sulphur-free fertilizer for only three years on Cecil sandy loam soil produced definite sulphur deficiency on seedling cotton plants. These symptoms disappeared after about two weeks, when the cotton roots apparently reached the zone of high sulphur concentration.

Cotton production and sulphur content of the cotton plant for varying rates of sulphur, Watkinsville, Ga., 1957

Sulphur* per acre	Seed cotton yield per acre	Sulphur in cotton plants	
		at thinning	at boll set
Pounds	*Pounds*	*Percent*	*Percent*
0	913	.17	.35
4	1,007	.25	.37
8	1,008	.36	.48
16	1,081	.55	.47
32	1,096	.85	.63

*S was derived from gypsum and all plots fertilized with 300 pounds 10-20-20 at planting + 50 pounds N as side dressing; lime to pH 6.5.

Cotton yield increases were highly significant for the 16 and 32 pounds of sulphur. The sulphur content of the cotton plant, both in the seedling stage and at maturity, increased with each rate of sulphur.

Initial soil samples taken in 1954 indicated a high sulphur concentration at the 12-18" soil horizon. Soil samples taken in 1957 indicate no detectable reduction in extractable sulphur.

Sulphur in rainfall averaged 6 pounds per acre. Apparently, very little of this sulphur is available to the cotton plant.

At present, there is enough sulphur in most fertilizers to meet the sulphur requirements of crops. The trend toward use of high analysis fertilizers frequently low in sulphur, however, may result in sulphur deficiencies. As a result, sulphur may have to be added to the soil in one form or another.

Georgia

HIGH RATES OF LIME REQUIRED TO CHANGE pH OF BLADEN SOIL

A. E. Royer, Fleming. --Various rates of limestone applied to Bladen clay loam resulted in marked increases in yield of Ladino clover and soybeans, even though relatively small changes in soil reaction could be detected.

In the new regional lime experiment with Coastal Bermuda grass and Ladino clover, five rates of limestone were applied. Two sources of limestone and two methods of placement were also included in the study.

The highest pH reached by any treatment 18 months after liming was 6.3, where 16 tons of calcitic limestone had been disked into the surface after seedbed preparation. A summary of soil pH changes is shown in the accompanying table.

The calcitic limestone was more effective in neutralizing soil acidity than was the dolomitic limestone. This was no doubt due to the greater solubility of the calcitic material. Also, the surface applied dolomite appeared to be more effective at increasing the pH of the surface 6-inch layer than plowed-down dolomite. In most treatments, however, the soil pH was raised less than one pH unit, even by rates of limestone as high as 8 tons per acre.

Effect of rate, source and method of incorporation of limestone on soil reaction at 0-6" Fleming, Ga.

Amount of lime per acre	pH after 18 months		
	Calcite on surface	Dolomite on surface	Dolomite plow-down
Tons	*pH*	*pH*	*pH*
0	4.3	4.4	4.4
2	4.8	4.7	4.5
4	5.1	5.0	4.7
8	5.6	5.3	5.2
16	6.3	5.6	5.2

New Mexico

P APPLIED IN '51 DOUBLED ALFALFA YIELDS IN '57

Ross W. Leamer, State College. --Phosphorus applied to alkaline western soils is available to plants over a long period of time. Additional evidence of this was obtained from a rotation experiment on Springer fine sandy loam at Tucumcari, New Mexico. In this experiment phosphorus was applied at rates of 0, 60, 120, 240, and 480 pounds P_2O_5 per acre when alfalfa was seeded in 1951. Alfalfa was cut for hay 3 times in 1951 and 5 times in each of the 3 subsequent years. Sorghum was grown in 1955 and 1956, then, the area was reseeded to alfalfa in the spring of 1957. One-half of each of the original plots received 240 pounds P_2O_5 per acre in 1956; the other half received no phosphorus, except that applied in 1951. Total yields of 3 cuttings of 1957 hay are shown in table 1.

TABLE 1.--Yield of alfalfa as affected by P_2O_5 treatments applied in 1951 and 1956, Tucumcari, N. Mex.

P_2O_5 in 1956 per acre	Alfalfa yield per acre				
	P_2O_5 applied in 1951 (Pounds per acre)				
	0	60	120	240	480
Pounds	*Tons*	*Tons*	*Tons*	*Tons*	*Tons*
0	0.88	0.84	1.06	1.17	1.98
240	2.05	2.07	2.25	2.37	2.57

The phosphorus applied in 1956 increased the yield of all plots. The increase was between 1.17 and 1.23 tons per acre, except on the plots receiving 480 pounds P_2O_5 per acre in 1951, where the increase was .59 tons per acre. Each series of 1956 plots showed a tendency toward increased yield with increasing rates of P_2O_5 in 1951. This indicates that even the lower rates applied in 1951 were affecting the 1957 yields on the phosphated plots, as well as the plots untreated in 1956.

All the hay and sorghum removed from these plots has been sampled for phosphorus content. The calculated amount of phosphorus removed from these plots is shown in table 2. The calculations of the amounts remaining are based on the assumption that equal amounts of soil phosphorus were removed from all plots. The negative values show that this assumption is not entirely accurate. Phosphorus stimulated root growth, as well as top growth, so the fertilized plants drew from a greater soil volume. No measure of the

volume of soil permeated by roots is available to adjust for the increased root activity. When the second cycle of the rotation is completed, a more detailed balance sheet can be developed.

TABLE 2.--P_2O_5 applied, removed in crops, and remaining in soil on rotation experiment, Springer fine sandy loam, Tucumcari, N. Mex., 1951-57

P_2O_5 Applied per acre		P_2O_5 Removed in crops per acre			P_2O_5 Remainder per acre
1951	1956	Alfalfa	Sorghum	Total	
Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
0	0	42.37	20.02	62.39	---
	240		26.62	68.99	233.39
60	0	101.87	22.16	124.03	-1.64
	240		28.80	130.67	238.32
120	0	186.92	26.01	212.93	-30.54
	240		33.90	220.82	208.17
240	0	247.39	31.05	278.44	23.95
	240		44.43	291.82	257.17
480	0	342.14	57.64	399.78	142.61
	240		61.82	403.96	385.03

North Dakota

GRASS, LEGUME, AND FERTILIZERS AFFECT SPRING WHEAT YIELDS

H. J. Haas and G. O. Boatwright, Mandan.--From results obtained in 1956 and 1957 at Mandan, it is apparent that spring wheat following grass or legumes may suffer from severe moisture deficiency and that this moisture deficiency may counteract any beneficial effect from the previous sod crop or fertilizer treatment. These data indicate that corn would be a better crop than wheat with which to follow sod. The land should be fallowed prior to growing wheat.

The study was initiated in 1949 to determine the effect of grass and grass-legume mixtures with and without fertilizers on the yields of wheat which followed. The study was conducted on soil previously classified as Cheyenne fine sandy loam which is in the process of being reclassified. Sod plots were fertilized annually in the fall of each year through 1954. Continuously cropped wheat plots were also included in the study and these received fertilizer each year from 1949 through 1957. One-half of each plot including the wheat plots was mowed and the plant material left on the plot from 1949 to 1955, inclusive. These plots are referred to as the nonharvested plots. Grass and legumes on the other portion of the plots were mowed and the hay removed, while the wheat was combined and the straw returned. There were 3 replications of each treatment. In the fall of 1955, all sod plots were plowed, and all plots were seeded to spring wheat in 1956 and 1957. Precipitation was near the average of 16.0 inches for each of the 2 years.

Average yields of wheat in 1956 and 1957 are presented in the accompanying table. Comparing the yields from the harvested and nonharvested treatments, yields were higher from the nonharvested treatment in every instance, except three. However, they were not significantly different in 1956 and were significantly different only in Series VIII in 1957. Differences in growth due to previous harvestings were noted early in the season on some treatments, but, apparently, there was not sufficient moisture to maintain

these differences until harvest. Also, there was considerable variability in the results between replications. Because of the variability in results, it would be difficult to say definitely that leaving all of the plant material on the land while it was in sod would benefit wheat yields which followed.

Average yields of wheat following different cropping and fertilizer treatments, Mandan, N. Dak., 1956-57

Cropping treatment 1949 to 1955	Wheat yield per acre			
	Fertilizer treatment 1949 to 1955[1]	Crop harvested 1949 to 1955	Crop not harvested 1949 to 1955	Mean of harvested and non-harvested
Series VII	*Pounds*	*Bushels*	*Bushels*	*Bushels*
Wheat	0-0	19.4	17.4	18.4
	[2] 30-30	23.9	25.2	24.6
Crested wheatgrass.....	0-0	17.2	19.6	18.4
	30-0	16.1	18.6	17.4
	30-30	18.4	18.9	18.6
	60-0	16.9	18.0	17.4
	60-30	17.6	19.4	18.5
Series VIII				
Wheat	0-0	14.6	16.4	15.5
	[2] 30-0	18.1	15.6	16.8
	[2] 30-30	21.0	23.4	22.2
Crested wheatgrass and alfalfa.	0-0	13.9	16.3	15.1
	0-30	16.8	14.8	15.8
Crested wheatgrass and sweet clover.	0-0	17.1	18.8	18.0
	0-30	16.0	19.0	17.4

[1] Pounds of nitrogen and P_2O_5 per acre respectively.
[2] These plots also received fertilizer in 1956 and 1957.

Comparing wheat yields from the previous cropping and fertilizer treatments, yields from the 30-30 treatment for continuous wheat were higher than any of the other treatments. Excluding the 30-30 treatment for continuous wheat, there was no significant difference between the other treatments in Series VII. Yields following crested wheatgrass and alfalfa mixture in Series VIII were significantly lower in 1956 than any of the other treatments. Early growth in both years indicated a marked response following the crested wheatgrass and alfalfa mixture and following crested wheatgrass with higher fertilizer treatments. However, the soil was extremely dry following the sod crops, and moisture became deficient at heading and filling time, which no doubt influenced yields.

Montana

LEVELED LAND RESTORATION UNDER STUDY

Ralph E. Campbell, Huntley. --A Fly Creek clay loam was cut in the process of leveling to a depth of 0.5 to 1.5 feet. Treatments of manure and commercial fertilizers were applied in various combinations. Rates used were: manure at 0 and 30 tons per acre; nitrogen as ammonium nitrate at 0, 100, 200, and 400 pounds N per acre; and phosphorus as concentrated superphosphate at 0 and 400 pounds P_2O_5 per acre.

Manure and phosphate were applied in the fall and plowed down. Nitrogen was side-dressed on corn the following spring. Funks G-35A hybrid corn was grown at a plant population of 22,000 plants per acre. Corn was harvested for silage on September 9.

Silage yields arranged in increasing order are shown in the accompanying table. Yields are on the basis of tons of silage per acre at 70 percent moisture.

Corn silage yields as affected by fertilizer on subsoil exposed by land leveling, Huntley, Mont., 1957

Soil treatment per acre			Silage yield per acre	Statistical Significance*
N	P_2O_5	Manure		
Pounds	*Pounds*	*Tons*	*Tons*	
0	400	0	9.6	
0	0	0	12.8	
400	0	0	15.2	
400	0	30	19.6	
0	0	30	19.8	
400	400	0	21.4	
0	400	30	21.5	
200	400	0	22.1	
400	400	30	22.2	
200	400	30	22.4	
100	400	0	22.6	
100	400	30	23.1	

*The length of the line includes yields that did not differ significantly among themselves at the 5 percent level of significance.

Silage yield over the whole field to which manure and phosphate was applied was about 23 tons per acre. The experiment was conducted on the area in the field of deepest cut of substantial size.

Of interest to note from the yields is that phosphorus alone probably depressed yields but was effective in increasing yields when applied in combination with nitrogen or manure. Nitrogen alone probably increased yields some but did not produce top yields.

Maximum yields were produced on the 100-400 + manure and 100-400 plots. This same result was obtained on a similar test on a Keiser clay loam subsoil.

SOIL STRUCTURE

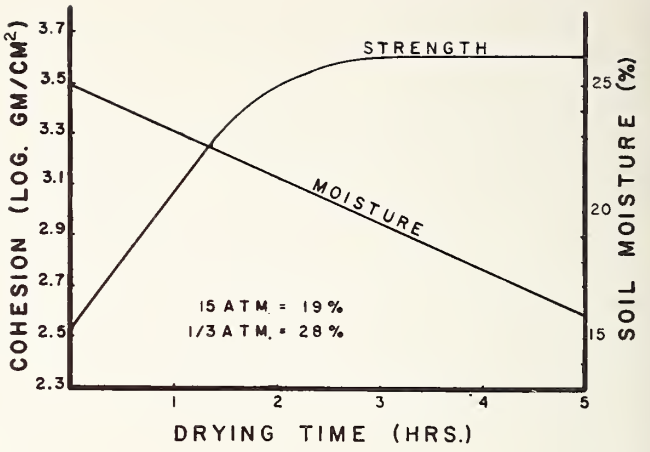
Alabama

DRYING OF SOIL INCREASES ITS MECHANICAL STRENGTH

William R. Gill, Auburn.--Studies on Lloyd clay soil have shown that the mechanical strength increases during drying until a moisture content slightly above the 15 atmosphere percentage is reached. The accompanying figure shows this relationship and that the strength increase is such that a maximum is reached even though there was a continued loss of water.

Since the conditions in this experiment were not as severe as drying in direct sunlight, it is probable, under good drying conditions in the field, that the time interval needed to secure maximum mechanical strength of clods may be appreciably less than two hours.

This strength-time relationship points out the desirability in conducting "once-over" or combined tillage operations such as plowing and harrowing. A few hours delay after plowing, for example, may result in higher clod strengths which may be very difficult to overcome by tillage. Once clods are formed it is generally necessary to expend considerable power to reduce them to a satisfactory seedbed condition.



Relationships of mechanical strength and soil moisture content to the drying time of Lloyd clay, Auburn, Ala.

CROPPING SYSTEMS

Wisconsin

LEGUMES CAN BE SEEDED IN WIDE CORN ROWS

R. E. Taylor, LaCrosse.--Interseedings of legumes in corn at LaCrosse were about equally successful whether the corn was 10, 20, or 30 inches high at the time of seeding. Earlier seedings were less promising. The corn was planted in rows spaced 56 inches apart. All interseedings reduced corn yields as compared to the non-interseeded check plot. The greatest reduction in yield was 10.4 bushels per acre from the 3-inch height at interseeding while reductions in yields from the other three interseeding heights ranged from 2.7 to 4.0 bushels per acre.

Effect of time of interseeding on corn yields, LaCrosse, Wis., 1956-7

Height of corn at seeding time	Corn yield per acre			Reduction in yield per acre
	1956	1957	2-yr. average	
Inches	*Bushels*	*Bushels*	*Bushels*	*Bushels*
3.....	97.2	85.1	91.2	10.4
10.....	102.2	95.6	98.9	2.7
20.....	99.6	97.8	98.7	2.9
30.....	98.8	96.5	97.6	4.0
Not interseeded..	106.7	96.5	101.6	---

Stands of legumes, although generally good, were somewhat poorer in seedings made when the corn was only 3 inches high. This is attributed to greater competition from weeds.

Interseedings of legumes directly in wide corn rows appear to be a sound cropping practice. Interseedings made when the corn is 10 to 30 inches high are most likely to be successful. In later seedings, soil moisture usually is more critical, whereas weeds are more of a problem in seedings made when the corn is very small. The weeds decrease corn yields as well as stands of interseedings.

COASTAL SUPERIOR TO COMMON BERMUDA IN N AND WATER USE

William E. Adams, Watkinsville. --Coastal Bermuda is almost twice as efficient as common Bermuda in the utilization of nitrogen and water. Table 1 compares the relative efficiency of nitrogen utilization by Coastal and common Bermuda grown on Cecil sandy loam soil at different nitrogen levels in 1957.

TABLE 1.--Pounds of forage produced by Coastal and common Bermuda for various nitrogen rates, Watkinsville, Ga., 1957

Treatments	Yield of oven-dry forage		
N - P_2O_5 - K_2O per acre	Per acre	Increase due to N	Increase per pound of N
	Coastal Bermuda following crimson clover		
Pounds	*Pounds*	*Pounds*	*Pounds*
0 - 100 - 100	4,160	---	---
200 - 100 - 100	12,300	8,140	40.7
400 - 100 - 100	14,060	9,900	24.7
	Common Bermuda following crimson clover		
0 - 100 - 100	1,960	---	---
200 - 100 - 100	7,200	5,240	26.2
400 - 100 - 100	8,640	6,680	16.7

When other nutrients are adequately supplied, Coastal Bermuda makes efficient use of nitrogen. The efficiency of nitrogen falls off as the rate of N increases, but common Bermuda falls off more rapidly than does Coastal. Both grasses gave yield increases up to the 400-N rate. Even at the 400-N rate, common Bermuda produced a ton of hay (15 percent moisture) for each 100 pounds of N, whereas Coastal Bermuda produced a ton of hay for each 70 pounds of N.

The data in table 2 illustrate the relation of fertilizer level to the efficiency of water used by Coastal and common Bermuda when grown in association with crimson clover and without irrigation in 1957.

The water utilized by Coastal Bermuda per ton of forage was about half that used by common Bermuda. As the fertilizer level increased, both Coastal and common Bermuda were more efficient in water utilization.

The root system of Coastal Bermuda was found to extend to at least 6 feet in this soil, whereas the root system of common Bermuda extended to only about 3-1/2 feet. This fact alone enables Coastal Bermuda to withstand much more severe periods of drought than common Bermuda.

TABLE 2.--The effect of fertilizer level on efficiency of water utilization by Coastal and common Bermuda, Watkinsville, Ga., 1957

Treatments	Coastal Bermuda		Common Bermuda	
N-P_2O_5-K_2O per acre	Forage per acre	Water used per ton of forage produced	Forage per acre	Water used per ton of forage produced
Pounds	*Tons*	*Inches*	*Tons*	*Inches*
0 - 0 - 0	1.78	11.3	0.96	21.0
100 - 50 - 50	4.38	4.6	2.46	8.2
200 - 100 - 100	6.15	3.3	3.60	5.6
400 - 200 - 200	7.84	2.6	4.53	4.5

Georgia

COASTAL BERMUDA IS SUPERIOR TO OTHER SUMMER GRASSES FOR GRAZING

H. G. Ukkelberg, Fleming, and B. L. Southwell, J. L. Stephens, Tifton.--Coastal Bermuda grass produced more forage and more beef per acre than three other summer grasses in grazing trials on Bladen and associated soils.

Grazing and clipping trials with four pasture grasses grown with crimson and ladino clovers have been in progress for four years on Bladen and associated soils. Coastal Bermuda, Pensacola Bahia, Argentine Bahia and Dallis grass were included in the study.

The pastures were grazed with young steers from late March until about November 1. The number of steers used per plot was adjusted to utilize the available forage without overgrazing.

Average beef gains and forage production for 1955 and 1956 are presented in the table. Data from the two previous years, 1953 and 1954, are not available from all plots. However on the plots where data are available for four years, beef gains were very similar to those shown in the table.

Beef production from four summer grasses, Fleming, Ga., 1955-56

Grass	Average steers per acre	Liveweight Gains		Total forage per acre*	Clover
		Per acre	Daily per steer		
	Number	*Pounds*	*Pounds*	*Pounds*	*Percent*
Coastal Bermuda....	1.59	369	1.05	9,826	23.8
Pensacola Bahia....	1.31	326	1.12	8,263	22.3
Argentine Bahia....	1.05	246	1.03	6,866	18.9
Dallis.....	0.98	244	1.12	6,672	28.0

*16 Percent moisture.

Coastal Bermuda produced the most grazing and largest gains of beef per acre with Pensacola Bahia grass second. Argentine Bahia and Dallis grass were approximately equal in beef production and were significantly lower than the other two grasses. Dallis grass had the lowest carrying capacity of the four grasses.

The differences in daily gains per steer were not statistically significant and indicate a uniformity in the quality of forage produced.

Forage yields as determined by clipping caged areas show that Coastal Bermuda produced the highest yield with Pensacola Bahia grass second. Argentine Bahia and Dallis grasses were significantly lower in yield than Coastal Bermuda. The percentage of clover in the forage produced was the highest with Dallis grass and the lowest with Argentine Bahia.

The coefficient of correlation between beef gains and forage yields was +.88 indicating a very good relationship between beef gains and forage production.

RESIDUE MANAGEMENT

Nebraska

TILLAGE INFLUENCES NITROGEN CHANGES IN SOIL

Fred A. Norstadt and T. M. McCalla, Lincoln. --Soil samples were taken in 1957 from rotation plots either subtilled or plowed over a period of years at Lincoln, Nebraska. The soil is classified as Sharpsburg silty clay loam, pH 5.6, and lays on a slope of 8.5 percent. The corn, oats, and wheat rotation was established in 1938. Another rotation containing sweetclover had been maintained in a crop succession of sweetclover followed by oats, wheat, and corn in varying successions. This rotation was started in 1943.

The concentrations of nitrogen found in the subtilled and plowed plots are shown in the accompanying table. Comparison of the nitrogen content by depths shows a highly significant difference between the 1- to 6-inch and 6- to 12-inch depths. The analysis of variance shows the interaction of tillage and depth to be significant when comparing the amounts of nitrogen accumulated under the 2 methods of tillage at the 0-1" and 1-6" depths. The surface inch of soil contained more nitrogen under subtilling than under plowing, but no measurable difference was found between the 2 tillage methods in the amount of nitrogen at the 1-6" depth. Although there was no significant difference between the 2 tillage methods in the amount of nitrogen at the 1-6" depth, there is a trend for a greater accumulation of nitrogen in the subtilled plots, and this trend is accentuated in the 6-12" depth.

The effect of stubble-mulch on the percent of nitrogen in the soil, Lincoln, Neb., 1957

Tillage	Nitrogen content[1]			
	Sampling depth in inches			
	0-1	1-6	6-12	0-12
	Percent	*Percent*	*Percent*	*Percent*
Plowed	0.163	0.164	0.128	0.146
Subtilled	0.171	0.166	0.135	0.151
Mean	0.167	0.165	0.131	0.148

[1] Determinations were made in duplicate on samples from each of 13 plots and averaged.

The difference in nitrogen content between the subtilled and plowed plots was 0.008 percent in the surface inch, a relative difference of 5 percent compared to plowing. For the 0-12" depth, the difference between subtilled and plowed plots was 0.005 percent, or a relative difference of only 3 percent compared to plowing.

The data for nitrogen content in the accompanying table indicate a trend for subtilling to increase the nitrogen content over plowing to the depth of sampling. Comparison of the amounts of nitrogen found at the 0-1" and 1-6" levels shows the concentration of nitrogen to be near the surface when the soil is subtilled. The plowed plots, where the crop residues were mixed with the soil, tend to have a higher concentration of nitrogen in the 1-6" layer as compared to the surface inch.

MOISTURE CONSERVATION

Montana

LISTED FALLOW SUPERIOR TO OTHER FALLOW METHODS

Truman Massee, Havre. --Listing fallow in the Plains of northern Montana is usually considered an emergency operation for control of wind erosion. Its use on sloping fields for control of water runoff has not been extensive. Probably one reason listing has not been used is that during the operation moist soil is turned up. Thus, it would appear that during successive listing operations large amounts of subsoil moisture would be lost after exposure and subsequent evaporation, thus lowering yields. Experimental data did not confirm this assumption.

Listing has been compared to moldboard plowing (followed by rodweeder) and subsurface tillage for fallowing. The site of this experiment was on nearly level land of the Joplin soil series. During the 17 years the test was in operation, it was found that fewer operations were needed for weed control during the fallow period by listing than the other 2 fallow methods.

During 11 of the 16 crop years, listed fallow produced the highest subsequent spring wheat yields, which included both good and poor cropping years. Subsurface tillage was best during 3 years, and plowing was best during 1 year. Yield data are given by years in the accompanying figure.

Yields in bushels per acre of spring wheat resulting from 3 fallow methods, 1942-1957, were as follows:

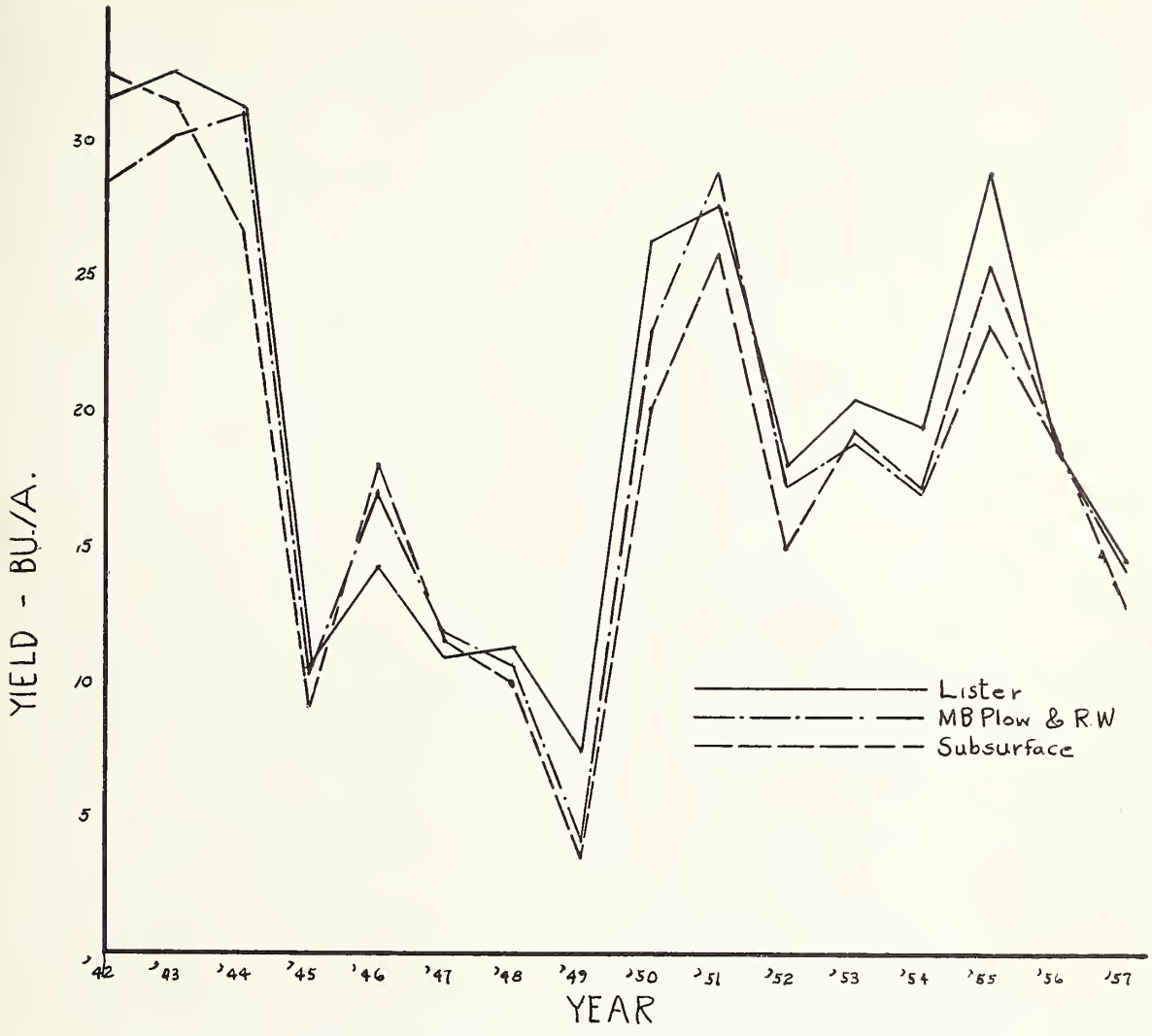
Lister	=	20.3
MB plow and R. W.	=	19.1
Subsurface	=	18.6
L.S.D. 5 percent	=	0.82 bu.
L. S. D. 1 percent	=	1.09 bu.
C. V	=	6.13 percent

F values were highly significant for treatments, years, and treatments x years.

Nebraska

SOIL MOISTURE IN SPRING MAY DEPEND ON PREVIOUS CROP

F. L. Duley and H. E. Weakly, Lincoln. --Moisture in the soil in the spring may depend very largely on the previous year's crop and the time it was harvested. Small grain harvested in July offers a long period during the fall when moisture may be stored. Weeds should not be permitted to grow, since they extract moisture from the soil profile to a depth of 2 to 4 feet. Small grain stubble should be kept standing to catch snow.



Yields of spring wheat resulting from three tillage methods for fallow. Havre, Montana 1942-1957.

The accompanying table shows the percentage of water in the soil in eastern Nebraska in the early spring of 1957 following different crop conditions.

This soil has a field moisture capacity of about 27 percent and a wilting point of about 13 percent. If a spring crop should be planted, the moisture in the small grain stubble land could produce a crop with only limited rainfall; whereas, after grass or alfalfa, the profile is so dry that a crop failure would be likely.

In planning any cropping system in the Great Plains, care should be taken that sufficient time is allowed between crops so that with good management there is likely to be enough moisture in the soil to start the next crop and bring it to maturity with the addition of normal rainfall. This important point should become a definite part of any Great Plains farming program.

Soil moisture available in early spring as affected by preceding crop, Eastern Nebraska, 1957

Soil depth	Soil moisture			
	Small grain stubble	Meadow	Bromegrass	Alfalfa
Feet	*Percent*	*Percent*	*Percent*	*Percent*
0-0.5	20.0	28.1	18.8	17.1
0.5-1	26.8	22.5	14.8	15.2
2	28.2	18.1	14.4	14.8
3	22.7	16.6	14.0	14.2
4	22.7	16.2	13.9	13.2
5	23.2	16.5	13.2	11.8
6	25.0	20.3	13.7	13.3

Wyoming

WATER-INTAKE MEASURED ON SHORTGRASS RANGE IN EASTERN COLORADO

Frank Rauzi, Laramie.--Water-intake studies near Calhan, El Paso County, in eastern Colorado, showed that near pure stands of blue grama grass absorbed more water than did near pure stands of buffalograss having approximately the same ground cover. A fence line separated the two areas studied. One side of the fence was chiefly blue grama grass and the other side had islands of buffalograss on which the tests were made.

Three tests were made on each side of the fence in October 1957, using a mobile infiltrometer. Water-intake rate during the second 30-minute period of the 1-hour test was used to compare the 2 vegetative associations.

Soil texture for the 0- to 2-inch depth was a clay loam, and below 2 inches was clay. The range site was classed as clay upland in the 15- to 19-inch rainfall belt. Both pastures had received year-long grazing by cattle for a number of years. The pasture with the buffalograss islands had been heavily utilized and the blue grama grass pasture moderately used.

Mechanical analysis of the 0- to 6-inch soil depth using the Bouyoucos method was made from a composite of 3 samples from each condition (see table 1). There was no difference in the soil texture between the 2 areas tested.

TABLE 1.--Mechanical analysis of the 0- to 6-inch soil depth for the 2 plant communities, Calhan, Wyo., 1957

Plant community	Sand	Silt	Clay
	Percent	*Percent*	*Percent*
Buffalograss sod.....	28.3	47.5	24.2
Blue grama grass sod.....	29.3	46.5	24.2

Average water-intake rates during the second 30-minute period of the 1-hour test were 0.62 and 0.92 inches per hour for the buffalograss and blue grama grass plots, respectively. The difference of 0.30 inches per hour between the buffalograss and blue grama grass plots was statistically significant at the 0.01 level. The average water-intake rate during the fourth 15-minute period for the 2 conditions was statistically significant at the 0.05 level.

Water-intake rates during the 1-hour test show that the rate of water intake during the first 15-minute period was the same for both communities (table 2). Water-intake rates during the second 15-minute period were highest on the blue grama sod and continued so for the remainder of the test.

Average amount of air-dried vegetation was 1,266 pounds per acre for the buffalograss plots and 1,730 pounds per acre for the blue grama grass plots. The difference in amount of vegetation present was not statistically significant. A correlation of water intake with total pounds of air-dried forage was not significant.

Since the differences in the amount of forage on the two areas was not significant and the soil texture was the same, other factors in determining water intake must have been effective for this site. The kind of vegetation and possibly soil compaction, both of which could have been affected by past use, may have been the controlling factors.

TABLE 2.--Average water-intake in 15-minute intervals and total for the 1-hour test, Calhan, Wyo., 1957

	Water intake				
	15-minute intervals				Total 1-hr.
	Inches	*Inches*	*Inches*	*Inches*	*Inches*
Buffalograss.....	0.43	0.20	0.20	0.11	0.94
Blue grama grass.....	0.44	0.33	0.27	0.19	1.23

California

PAN EVAPORATION RELATED TO EVAPOTRANSPIRATION BY PHREATOPHYTES

Harry F. Blaney, Los Angeles.--Before the available water supply of a river basin can be satisfactorily ascertained, careful consideration must be given to the consumptive water requirements of phreatophytes and other water-loving vegetation. The results of research studies indicate that these plants generally use from 50 to 100 percent more water than most irrigated crops in semiarid and arid climates of the West. The U. S. Geological Survey has estimated that the total area of phreatophytes is over 15 million acres in the 17 Western States and that the total use of water by these plants is between 20 and 25 million acre-feet annually or about twice the average annual flow of the Colorado River.

Measuring evapotranspiration by vegetation under each of the physical and climatic conditions of river basins is expensive and is time consuming. Analysis of measurements made by irrigation engineers of the Department of Agriculture in California, Colorado, New Mexico, and Texas indicate that observed evaporation data from U. S. Weather Bureau pans may be used as a means of estimating evapotranspiration by water-loving vegetation, when the relation of the two values is known for a particular area. For example, a five-year study made by Muckel and Blaney on pan evaporation and evapotranspiration by native vegetation with water tables at different depths, in San Luis Rey Basin, California, indicate a relationship of water use by tules, cottonwoods, brush, and grass to evaporation from a Weather Bureau pan. The results are summarized in table 1.

Evaporation from pans has been used to estimate evapotranspiration losses by vegetation in river basins such as the Rio Grande and the Pecos River. Table 2 illustrates the results of computed annual rates of evapotranspiration by natural vegetation growing in the Pecos River Valleys of New Mexico and Texas, based on evaporation pan measurements made at seven stations.

TABLE 1.--Comparison of evapotranspiration by native vegetation growing at different water table depths to evaporation from a Weather Bureau pan, San Luis Rey Basin, California

Classification	Depth of water table	Annual water consumption	Ratio water use to evaporation
	Feet	*Inches*	
Pan evaporation.....	0.0	60.8	1.00
Tules.....	0.0	57.5	0.95
Cottonwoods.....	3.0	92.7	1.52
Cottonwoods.....	4.0	62.3	1.02
Brush-grass.....	4.7	45.4	0.75
Grass.....	12.0	14.0	0.23

TABLE 2.--Average computed rates of annual evapotranspiration by phreatophytes based on pan evaporation data and climatic factors, Pecos River Basin, New Mexico, and Texas

Location	Computed evapotranspiration			
	Saltcedar along river	Saltcedar average	Brush areas away from river	Grass and weeds away from river
New Mexico	*Inches*	*Inches*	*Inches*	*Inches*
Las Vegas.....	51.6	43.2	34.8	21.6
Fort Summer.....	64.8	51.6	43.2	27.6
Roswell.....	67.4	56.4	45.6	28.8
Carlsbad.....	72.0	60.0	48.0	30.0
Texas				
Barstow.....	71.8	58.8	46.8	30.0
Balmorhea.....	72.0	60.0	48.0	30.0
Fort Stockton.....	72.0	60.0	48.0	30.0

TILLAGE AND CULTURAL PRACTICES

Minnesota

WHEEL-TRACK PLANTING SHOWS PROMISE IN WESTERN MINNESOTA

C. A. Van Doren, Morris.--The yield of No. 2 corn averaged slightly greater from wheel-track-planted plots than from conventionally planted plots. Treatments were replicated four times on each of five farms.

Stand counts, bulk density measurements, and soil moisture contents were determined during the season. Plant population was slightly less on the wheel-track-planted plots. Bulk density measurements were made late in the summer. The wheel-track-planted plots had an average bulk density in the surface soil of 0.80, while the conventionally tilled plots average 1.00. The soil on the wheel-track-planted plots was noticeably more friable and less compact than the conventionally tilled plots. The rough and loose condition of the surface soil contributed to an increase in infiltration. There was

a significantly greater amount of soil moisture in the 0-18-inch depth of the wheel-track-planted plots. However, rainfall was excessive throughout the season and all plots had adequate moisture.

It is expected that this practice will spread rapidly to farms in the area. Cost of corn production should be reduced a minimum at $4 per acre by the use of wheel-track planting.

The yield of corn as influenced by wheel-track planting, Minnesota, 1957

County soil type	Corn yield per acre		
	Conventional		Wheel track
	Early plow	Late plow	
	Bushels	*Bushels*	*Bushels*
Stevens Hamerly silty clay.....	75.4	75.0	74.5
Swift Barnes loam.....	55.5	66.5	72.5
Swift Aastad silt loam.....	67.5	66.7	71.9
Pope Barnes No. 1.....	72.9	73.3	73.2
Pope Barnes No. 2.....	60.7	62.2	64.4
Average.....	66.4	68.7	71.3

New York

STUBBLE-MULCH TILLAGE SYSTEM DEVELOPED FOR HIGH GRAIN YIELDS

G. R. Free, Ithaca. --An improvised double-cut plow has been highly effective in preparing a stubble-mulch seedbed at Marcellus, New York. This plow, which is similar to the equipment used successfully in Virginia for preparing seedbeds for corn following sod, plows in two layers and inverts only the top two or three inches.

A four year rotation of corn, oats, wheat, and hay was followed over the 12-year period with one crop each year. Seedbeds were prepared by (1) conventional turn plowing; (2) stubble-mulch plowing; and (3) disking. Fertilizer treatments for each of the three tillage methods were as follows:

High - 800 pounds per acre of 10-10-10 plus 300 pounds of 4-12-8 in the planter for corn; 300 of 4-16-4 for oats; and 600 for 4-12-8 for wheat.

Normal - 300 pounds per acre of 4-12-8 for corn; 250 of 0-20-0 for oats; 300 of 4-12-8 for wheat.

Manure - 400 pounds per acre of 0-20-0 mixed with manure at 8 tons per acre for corn; nothing additional for oats; 300 of 4-12-8 for wheat plus a top-dressing of manure during the winter at 4 tons per acre.

During the period 1945 through 1949 when stubble-mulch seedbeds were prepared by an ordinary plow with moldboards removed, yields for the three grain crops under both stubble-mulch plowing and under disking averaged 69 percent of those under conventional turn plowing. Since 1950 when stubble-mulch plowed seedbeds have been prepared by the improvised double-cut plow, average yields under stubble-mulch plowing were increased

to 97 percent of those obtained by conventional plowing. Average yields for the grain crops under disking remained at the low level of 77 percent. Reasons for the slight yield depression under stubble mulch are being investigated in another experiment started in 1956. Still further improvement in relative yields may be possible.

Over the 12-year period, grain yields under the normal fertilizer treatment averaged 89 percent of those under the high. Yields under the manure treatment averaged 98 percent of those under the high.

The experiment was terminated in 1956 and residual effects measured in 1957 with all 54 plots conventionally plowed, heavily fertilized, and planted to corn. Yields averaged 114 bushels per acre with no significant effects of previous treatments.

All crops in these experiments were contoured, and, because of the efficiency of this practice in controlling erosion on moderate slopes of Honeoye silt loam, no great differences between the tillage treatments on control of runoff and erosion were noted. Stubble-mulch plowing is now under severe testing on runoff plots along with the system of minimum tillage known as plow plant.

SOIL AND WATER MANAGEMENT--GENERAL

California

STUDY STARTED OF SUBMERGED BAY LAND FOR POSSIBLE RECLAMATION

Dean C. Muckel, Berkeley. --A study in cooperation with the U. S. Army Engineers to determine suitability for agricultural purposes of submerged lands in San Pablo, Suisun, and South San Francisco Bays is under way. Samplings of bottom sediments were taken to depths of 15 feet from a floating barge at 30 locations during October and November. These are now being processed in the laboratory. The survey is confined to areas where the depth of water is 6 feet or less at Mean Lower Low tide. Involved are 75,000 acres of submerged lands plus 59,000 acres of tideland and 97,000 acres of marshland.

California

EVAPOTRANSPIRATION LOSSES ESTIMATED FOR BARRIER PLANS

Dean C. Muckel, Berkeley. --In response to a request from the U. S. Army Engineers, estimates were made of evapotranspiration losses for the critical year 1930-31 in the event barriers to create fresh water bodies were built in San Pablo, Suisun, and South San Francisco Bays. The estimates were made for "present conditions" and conditions under "maximum probable reclamation" and were based on data collected during the past five years.

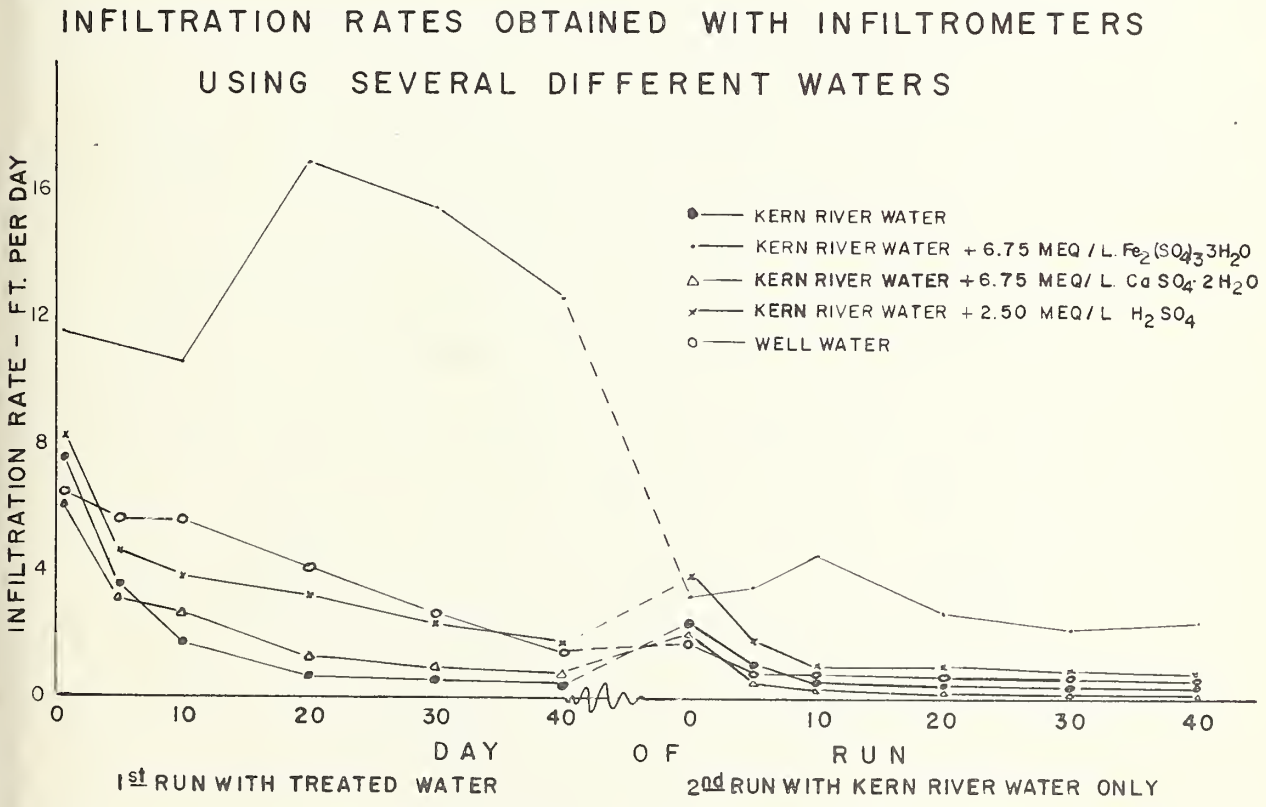
The estimated evapotranspiration losses under "present conditions" amounted to 1,325,000 acre-feet. In the month of July, alone, the losses were estimated at 204,000 acre-feet. In order to maintain a constant water level in the bays, a continuous flow of approximately 3,300 cubic feet per second would be required. Under "maximum probable reclamation" the water losses would be reduced at 642,000 acre-feet per year with the July requirement being 98,000 acre-feet.

Under such a barrier plan, there would be 270,500 acres of water surface involved and 35,000 acres of water-consuming marshlands for "present conditions". Under "maximum probable reclamation," there would be 120,300 acres of water surface and 15,380 acres of marshland. These estimates are for a barrier plan which converts maximum salt water areas to fresh water areas. For other barrier plans under consideration, there would be smaller losses.

$Fe_2(SO_4)_3$ HAS SLIGHT SUSTAINED EFFECT ON INFILTRATION

Eldred S. Bliss and Curtis E. Johnson, Bakersfield.--Tests which chemical additives (previously reported in Quarterly Progress Report No. 10, p. 5) showed that the addition of a constant supply of ferric sulphate at the rate of 6.75 me/liter to canal (Kern River) water increased infiltration rates from 2 to 30 times those of untreated controls. Other materials tested effected much lower infiltration rates.

Following a trial period of 150 days, all infiltrometers were shut down and allowed to dry. A rerun was then made with untreated canal water to determine whether any residual effects remained from the previous treatments. The accompanying figure summarizes the results of the first 40 days of both runs.



It is apparent that the beneficial effect of the ferric sulphate treatment on infiltration rate is continuing but at a greatly reduced intensity. The peak rate on the second run was attained after eight days and was 4.7 feet per day compared to a peak of 15.7 feet per day obtained after 18 days on the first or treatment run. Thirty days later, the rate on the second run had declined 2.4 feet per day, a decline of 2.3 feet per day or about 50 percent. On the first run, the rate 30 days after the initial peak was 14.4 feet, a decrease of only 1.3 feet or about 8 percent. The differences between the other 3 treatments and the control on the second run are small and, probably, are not significant. Rates on all treatment groups had dropped to a small fraction of those at comparable times on the first run.

Two factors which contributed to the relatively low rates obtained on all infiltrometers on the second run were the lower temperature during the run and the lack of proper drying between runs. It has been found that the infiltration rate will recover, if the soil is dried to about the wilting point. During the shutdown between the first and

second runs, drying conditions were poor, and the surface soil did not dry to this extent. Average water temperatures were about 10 to 15 degrees centigrade lower during the second run. It was not possible to evaluate these factors quantitatively. However, all infiltrometers were equally subject to these factors.

It is not known what effect, if any, the $Fe_2(SO_4)_3$ may have on the soil, or if lesser concentrations of $Fe_2(SO_4)_3$ would be equally effective. This is an important consideration from the standpoint of an economic application. The treatment rate used in this experiment totaled about 360 tons of $Fe_2(SO_4)_3$ on an acre basis over the 40-day period for the first run.

California

DECREASED OM RAISES INFILTRATION OF RECHARGE BASINS

Curtis E. Johnson, Bakersfield.--The chlorination of water supplied to a small test pond to prevent the decline in infiltration rate associated with microbial activity in the soil during prolonged submergence has been previously discussed in Quarterly Reports No. 4 and No. 7. Soil samples taken before and after this 332-day chlorination test showed that the organic matter content and aggregation of the soil had been greatly reduced by the oxidizing action of the chlorine as indicated in the accompanying table. In order to determine the effect of the removal of organic matter on subsequent infiltration rates, the test pond was allowed to dry, and a new test was started.

Aggregation and organic carbon content of pond soil, Bakersfield, Cal.

Depth	Before chlorination run		After chlorination run		After final run	
	Agg.	Org. Carbon	Agg.	Org. Carbon	Agg.	Org. Carbon
Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
0-3	54.8	0.34	33.3	0.07	41.1	0.08
3-6	50.8	0.28	35.0	0.07	35.2	0.06
6-9	41.8	0.14	31.9	0.02	35.7	0.05
9-12	52.0	0.11	31.0	0.09	35.1	0.05

Results of this latest test show that a lower than normal infiltration rate is obtained during the initial 40 days of submergence. This is attributed to loss of soil structure coincident with the reduction of organic matter content during the previous chlorination treatment. However, for a period of continuous submergence longer than 90 days, more water is infiltrated, due to the fact that there is less organic matter, a lower level of microbial activity, and less clogging of soil pores by products of microbial metabolism.

Many soils have a natural soil structure which allows infiltration at a rate sufficiently rapid for short-term water spreading (30 days or less). In many places, the same area must also be used for long-term spreading, and water may then be applied continuously for several months. In this case, expensive treatments to improve soil structure are necessary to compensate for the decline in rates with time due to clogging of pore space with products of microbial activity. Reduction of microbial activity during prolonged submergence by some means which would not destroy the soil structure would make these soil treatments very much more effective or perhaps unnecessary.

SUCTION RESTORES INFILTRATION RATES IN INFILTROMETERS

Leonard Schiff, Bakersfield.--Suction appears to be the most efficient way of removing fines from aquifer surfaces in infiltrometers which cause clogging and greatly reduced infiltration rates.

Eight infiltrometers three feet long and one foot in diameter were inserted one foot into aquifer material in ground water recharge tests. Infiltration rates due to clogging (largely by clay) dropped from a high of about 60 to 8 or less feet per day under a surface depth of water of 1.9 feet in about 2 months. Calcium chloride was added to the water to bring the water in the infiltrometer and the amount of water entering the infiltrometer for a given period of time to a concentration of 20 milliequivalents per liter. No appreciable changes in infiltration rate occurred in this attempt to flocculate clogging material. Calgon (sodium hexametaphosphate) added at a rate of two grams per 1000 cc of water in an attempt to disperse clogging material had little effect on the infiltration rate.

Suction, scraping, and "harrowing" were tried as mechanical approaches to restoring infiltration rates. Each mechanical treatment was tried in two infiltrometers. Suction was applied by pumping through a garden hose moved gently on the surface of two of the infiltrometers. A screen was placed over the suction end of the garden hose to prevent removal of the aquifer material (largely sand). A semicircular piece of metal was used to scrape and remove about one-fourth inch of material from the surface of the aquifer material. Harrowing was simulated by using a semicircular board through which nails projected to disturb the surface in an attempt to distribute the fines through a greater depth. Water was added during the treatments to maintain the water level in infiltrometers at the 1.9-foot head. Major results are given in the accompanying table.

Changes in infiltration rate in infiltrometers, Bakersfield, Cal., 1957

Infiltration per day						
Initial	"Harrowing"		Scraping		Suction	
Aug. 14	Just before Oct. 20	After Oct. 21	Just before Oct. 20	After Oct. 21	Just before Oct. 20	After Oct. 21
Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
60	7	17				
80	5	36				
70			1	33		
80			7	18		
45					8	44
60					3	52

Scraping may tend to "slick" the surface in various locations. Suction has the advantage of removing fines without removing aquifer material. It was necessary to clean the screen occasionally. On a large scale, this could be worked out mechanically. "Harrowing" was partially effective, however, no fines are removed, and clogging materials which were in a thin plane were distributed over a greater depth. In time, this entire depth will clog.

GRASS AND LEGUME ESTABLISHMENT STUDIED IN MILK RIVER VALLEY

Gilbert Schumaker and Sterling Davis, Chinook. --Several species of grasses and legumes are adapted to the Bowdoin and Harlem heavy clay soils under irrigation according to one year's results at the Milk River irrigated experimental plots. Of the 18 species of grasses and legumes tested, alfalfa and smooth bromegrass were superior in both stand and yield in 1957. Vernal alfalfa yielded 3.5 tons of hay per acre and Lincoln brome yielded 2.25 tons per acre during the season.

Other grasses showed excellent stands with yields above one ton of field-dry hay per acre and have promise of being adapted to this soil. Although several species in the nursery produced poor stands, it is possible that ideal conditions for seedling growth were not present for these particular species.

These results are from a nursery seeded in the summer of 1956. An application of 6-30-0 fertilizer at the rate of 600 pounds per acre was broadcast previous to seeding. During the period of germination and emergence, the soil was kept moist by irrigating with a sprinkler system. A straw mulch was effective in reducing evaporation and keeping the soil surface moist. Nitrogen was applied on the grasses at the rate of 100 pounds N per acre early in the summer of 1957.

Several species made good growth early in the season After an early cutting, regrowth was sufficient for a second cutting, and a third in several instances. Plant species grown in this nursery are listed in the accompanying table with type of stand obtained, number of times cut, and total yield in 1957.

Stand and yield of hay produced by different species of grasses and legumes, Chinook, Mont., 1957

Species	Stand	Number of cuttings	Weight of field-dry hay per acre
			Pounds
Vernal alfalfa	Excellent	3	7,108
Lincoln brome		2	4,657
Reed canarygrass		1	3,683
Potomac orchardgrass		1	3,602
Alta fescue		3	3,393
Meadow foxtail		2	2,332
Tall oatgrass	Good	3	2,903
Timothy		1	2,770
Tall wheatgrass		1	2,505
Intermediate wheatgrass		1	2,117
Pubescent wheatgrass		1	1,321
Western wheatgrass (Mandan 265)	Fair	1	863
Empire birdsfoot trefoil		1	1,118
Alsike clover		1	1,191
Ladino clover	Poor	1	0
Russian wildrye		1	572
Ruby milk vetch		1	0
Nordan crested wheatgrass		1	830

The nursery is being continued in order to evaluate the ability of these species to maintain themselves on this soil over a period of years. Since the nursery is only one year old, most of the plant species have not reached their peak production. Some of the species which did not yield well in 1957 may be superior in survival and yield over a period of years.

Although only a fair stand was obtained with Mandan 265 western wheatgrass, this grass spreads by means of rhizomes and the stand thickened during the 1957 season. The application of nitrogen aided in root extension and increased stand. Stands of some other rhizomous species may be expected to increase in a similar manner.

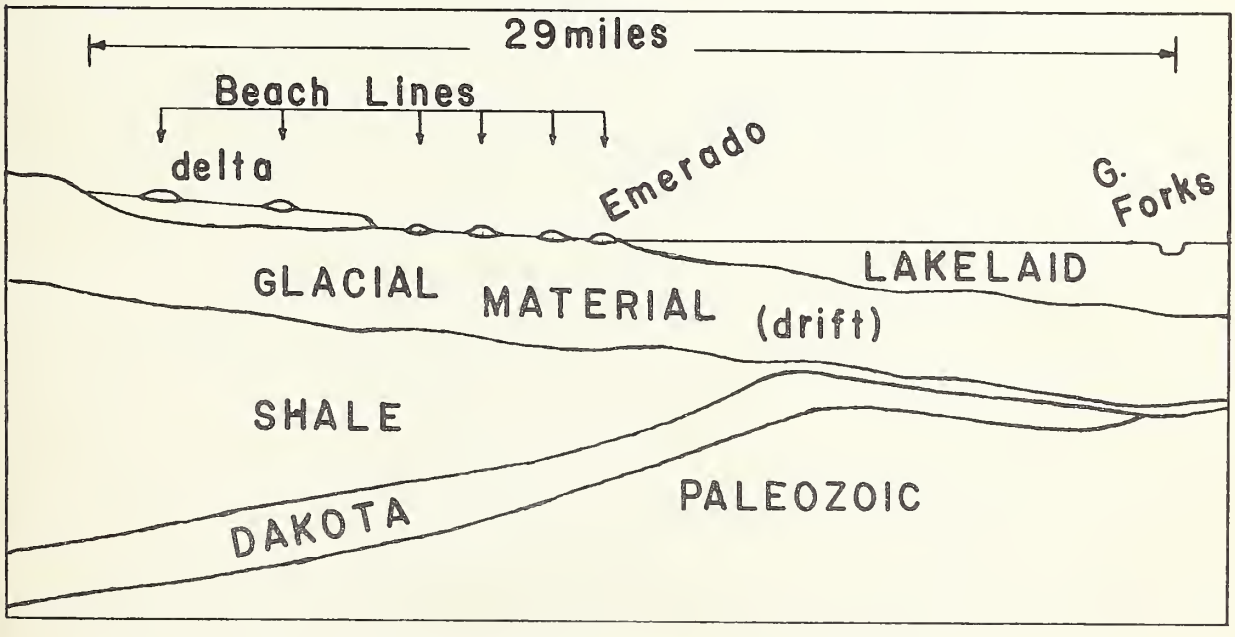
Knowledge of which hay crops are adapted to this soil is limited. Results from this nursery will serve as a guide in setting up future seedings for experiments to study the problems encountered with this heavy clay soil.

North Dakota

SALINE SOILS OF THE UPPER RED RIVER VALLEY HIGH IN MAGNESIUM

Fred M. Sandoval, Leo Benz, Rome Mickelson, and Carl Carlson, Mandan.--Considerable acreage in the upper Red River Valley in North Dakota is affected by excessive concentrations of salts, the dominant constituent being magnesium. The problem is associated with high water tables. Studies have been made primarily in Grand Forks County, where over 200,000 acres are severely to moderately affected. The valley is an ancient glacial lakebed which slopes gently to the north less than a foot per mile.

Principal physiographic and geologic features which appear important to the overall problem are schematically illustrated in the accompanying figure. The major problem areas are located on the deeper (approximately 130 feet deep at Grand Forks) lacustrine sediments having a west-east slope of 1 to 2 feet per mile. Ancient beach lines and shallow lacustrine sediments overlying areas between beaches run diagonally northwest.



Cross section of glacial Lake Agassiz showing physiographic units and geology west of Grand Forks, North Dakota.

Considerable saline acreage lies between the beach lines immediately overlying the moraine paralleling the Emerado and adjacent beaches. The beach soils are sandy and gravelly; the glacial material is quite clayey. The delta area presumably was formed

under water. These deltaic deposits are much coarser than the lakelaid sediments nearer the Red River to the east. Position of the ancient beaches on these deposits gives clues on relative age between the soil materials. Prominent beaches and the Elk River Delta, both lie at higher elevations than the major problem areas. Three or four different soil series are found in the saline areas and are being characterized. The chemistry of the soil (C & D horizons) and the ground water are somewhat similar. Magnesium-calcium ratios as wide as 10:1 have been found. The accompanying table gives some characteristics of 2 saline profiles. Gypsum is common in numerous locations.

Laboratory data from 2 saline profiles near Grand Forks, N. Dak.[1]

Profile study	Horizon	Depth	Est. text.*	Sat.	Elect. cond.**	Paste pH	Soluble ions per liter**					Exch. Na.	Hydro. Cond.***
							Ca	Mg	Na	SO_4	Cl		
		Inches		*Per-cent*	*mmho/cm.*		*meg.*	*meg.*	*meg.*	*meg.*	*meg.*	*Per-cent*	*cm./hr.*
4	A_1	0-5	Sil	75	8	7.3	40	39	19	55	38	3	1.0
	A_1	5-8	Sil	70	15	7.6	36	116	51	108	92	5	3.7
	Aca	8-20	Sicl	59	14	7.8	17	116	48	82	97	7	3.6
	Cca	20-36	Sil	49	16	7.8	14	151	48	102	110	10	3.2
	Dg	36-60	Sic	82	17	7.6	32	164	47	135	106	7	0.1
5	A_1	0-8	Sil	73	27	7.2	73	71	171	66	243	11	3.1
	A_1ca	8-22	Sil	55	28	7.4	59	128	130	22	293	12	8.0
	C_1	22-32	l	44	31	7.3	67	153	138	25	331	17	5.8
	C_2	32-43	vfsl	42	49	7.2	123	276	207	38	566	17	1.3
	D	43-54	Sil	47	54	7.1	137	314	233	40	642	19	0.8
	Dg	54-72	Sicl	49	56	7.1	135	315	248	36	661	17	0.4

[1] Profile 4 is gypsiferous; profile 5 is chloride dominant.

*Textural classes: vfsl = very fine sandy loam; l = loam; Sil = silt loam; Sicl = silty clay loam; Sic = silty clay.

**Analyses on saturated soil extract.

***Hydraulic conductivity; stable rate (after 24 hrs.) on disturbed soil with distilled water.

Oklahoma

WINTER WHEAT GRAIN YIELDS NOT REDUCED BY PROPER GRAZING

H. H. Finnell, Goodwell.--Several observations were made in a study of 844 records of winter wheat, grazed during the period of 1946-51 in a southern high plains. Records were from a portion of five States centering on the Oklahoma Panhandle.

Amounts of forage dry matter removed from the fall and winter growth by grazing did not affect grain yields harvested; however, grain yield was reduced by extending the grazing period into the spring growing season.

Other factors affecting grain yields which did not show a significant relation to pasturage yield were coarseness of soil texture, negative; amount of preparatory tillage, positive; insect infestations of green aphid, negative; stubble-mulch, negative; fall and winter precipitation, positive; lateness of seeding date, positive.

Factors affecting pasturage yield and grain yield, but in the opposite way, were weed growth during land preparation, positive to pasture yield, negative to grain yield; and length of grazing period, positive to pasturage yield, negative to grain yield.

Significant to pasturage yield alone was water conservation practices, positive.

These results were observed during a period of more than average rainfall under average farm conditions where cattle were removed from the field when muddy and the grazing terminated upon noticeable lengthening of the joints in the spring.

Grazing too late in the spring was indicated to be the most serious hazard to grain yield which could be guarded against.

The average yield of grazed fields was 14.6 bushels, and of ungrazed fields, 14.8 bushels per acre.

Texas

SORGHUM SEEDING RATE DOES NOT AFFECT EVAPOTRANSPIRATION

J. J. Bond, T. J. Army, and O. R. Lehman, Bushland. --Row spacing and seeding rate had no measurable effect on total evapotranspiration by sorghum during the growing season. Total water use of all seeding rates and row spacings averaged 13.6 inches from seeding time to harvest.

To determine the interrelationships of seeding rates; row spacings; and water use of a dryland sorghum crop, a controlled experiment was initiated on a Pullman silty clay loam at the Southwestern Great Plains Field Station, Bushland, Texas, in 1957. Texas Hybrid RS 610 was planted in 20- and 40-inch rows.

Under dryland conditions, potential evapotranspiration usually far exceeds actual evapotranspiration. On the basis of preliminary calculations potential evapotranspiration at Bushland, Texas, approximates 22 to 23 inches, when the sorghum crop is seeded around June 15. Therefore, the dryland sorghum crop could normally be expected to use all of the available moisture during the growing season regardless of variability in row spacing and seeding rate.

When evapotranspiration was examined on the basis of phenological periods, it was found that more water was used early in the growing season under a 20-inch row spacing than under a 40-inch as seen in the accompanying table. As the growing season progressed, the 20-inch row spacing used somewhat less water than the wide-row plantings. The reduction in water use by the 20-inch plantings as the growing season progressed apparently reflects a depletion of the available moisture supply. The increased early use of water in a narrow row spacing might have been detrimental to yields, if subsequent rains had not replenished the soil moisture supply.

The 13.6 inches of evapotranspiration resulted in a grain yield of 3,778 pounds per acre in the 20-inch spacing and 3,640 pounds per acre in the 40-inch spacing.

Evapotranspiration of hybrid sorghum by phenological periods as affected by row spacing, Bushland, Tex., 1957

Phenologic period	Period	Evapotranspiration	
		20-inch spacing	40-inch spacing
		Inches	*Inches*
Seeding to boot.....	7/2-8/12	7.2	6.5
Boot to heading.....	8/13-8/26	2.3	2.2
Heading to soft dough.....	8/27-9/16	2.8	3.1
Soft dough to harvest	9/17-10/31	1.5	1.6

$LSD_{.05} = 0.48$

Ohio

WATERSHED RUNOFF INCREASED BY FROZEN SOIL

L. L. Harrold and R. E. Youker, Coshocton.--Runoff producing rains on frozen ground are not common in this area. There have been fairly long periods of frost in the soil during the 20-year period of record, but it has most often disappeared before the rainfall season.

In January 1958, two rainstorms occurred when frost was still present in the soil on north and easterly slopes but not on south and westerly slopes. Runoff and infiltration data for two meadow watersheds for these storms are given in the accompanying table. The watershed on the east slope retained its frost longer than that on the southwest slope. There was practically no frost during these storms on the southwest slope watershed. Runoff from the frozen soil of the east slope watershed was much greater than the runoff from the frost-free southwest slope. Infiltration rates during the period of maximum rainfall rate ranged from 0.06 to 0.09 inch per hour on the thawed soil and from 0.00 to 0.03 on the frozen soil. Total infiltration for the two storms was 0.73 inch on the thawed and only 0.09 inch on the frozen soil.

Effect of frozen ground on runoff and infiltration on meadow watersheds, Coshocton, O., January , 1958

Date	Rainfall	Runoff		Infiltration			
				Amount		Rate per hour	
		East slope	Southwest slope	E	SW	E	SW
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
January 21 (a).....	0.26	0.26	0.03	0	0.23	0	0.06
January 21 (b).....	0.13	0.13	0.03	0	0.10	0	0.07
January 24-25.....	0.44	0.35	0.04	0.09	0.40	0.03	0.09

Note: Ground on east slope watersheds frozen. Only traces of frost in soil on the southwest slope watershed. (a) and (b) are separate storms on the same date.

HYDROLOGY-LAND USE INFLUENCES

Michigan

COVER AFFECTS RUNOFF ON WATERSHEDS

Nina C. Cottom, East Lansing.--The effect of cover on the two cultivated watersheds is shown in the amount of water loss which occurred during the winter months, particularly the months of January, February, and March of 1957 and 1958. Temperatures were below normal during January and most of February 1958. However, temperatures reached 46 degrees on both the 24th and 25th of February. There were approximately 3 inches of snow on the ground on the 24th at the time runoff started. These higher temperatures caused runoffs amounting to a total of 0.1584 inch on Watershed A and 0.1820 inch on Watershed B. No runoff occurred at the wooded watershed.

Under minimum tillage practice, Watershed A was planted to corn in 1956, with a seeding of mammoth clover and sweetclover on June 22, 1956 for the winter cover crop. Watershed B had been in alfalfa-brome during 1955 and 1956. Both watersheds were

plowed and planted to corn May 17 to 21, 1957. In both 1957 and 1958, the ground was frozen on both watersheds until late February. The accompanying table shows the difference in runoff from these watersheds.

Precipitation and runoff from two cultivated watersheds as affected by cover, East Lansing, Mich., 1957-58

1957					1958				
Date	Runoff		Soil condition**	Cause of RO*	Date	Runoff		Soil condition**	Cause of RO*
	Watershed A	Watershed B				Watershed A	Watershed B		
	Inches	*Inches*				*Inches*	*Inches*		
1/21	0.1149	---	Frozen	R-SM					
2/8	0.2860	0.0355	Frozen	R					
2/9	0.6035	0.1699	Frozen	R					
2/18	0.0047	---	Frozen	SM					
2/20	0.0015	---	Frozen	SM					
2/21	0.0015	0.0016	Frozen	SM					
2/24	0.0323	0.0155	Frozen	R-SM	2/24	0.0833	0.0879	Frozen	SM
2/25	0.0744	0.0129	Not F.	R-SM	2/25	0.0751	0.0941	Frozen	SM
3/11	0.3163	0.0289	Not F.	R					
3/20	---	0.0011	Not F.	R-SM					
Total	1.4351	0.2654				.1584	.1820		

*RO - Runoff
R - Rain
SM - Snowmelt

**Data taken from soil temperature units buried in vertical column under sod.

Precipitation

Month	1957				1958			
	Snow	Rain-snow	Rain	Total	Snow	Rain-snow	Rain	Total
	Inches	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*	*Inches*
Jan.....	.42	.74	---	1.16	1.52	.05	---	1.57
Feb.....	.19	---	.86	1.05	.60	.18	---	.78
Mar.....	.48	---	1.40	1.88	.15	.12	---	.27
	1.09	.74	2.26	4.09	2.27	.35	---	2.62

Mississippi

VERY HIGH GULLY EROSION MEASURED IN STUDY

R. Woodburn, Oxford. --Resurveys of the two-year-old pools above small dams in the special-study gullies show several very high gully erosion rates. One gully in Carroll County produced over nine vertical inches per year equivalent erosion rate over the bare portion of its area. This is much in excess of the two inches per year rate currently used for design purposes in this area. There is need for better classification of gullies with respect to their erodibility, as there is apparently a vast difference between them. Such difference may greatly overshadow effects of various treatments.

Mississippi

SHIFTING CHANNEL BEDS PRESENT PROBLEMS IN STREAMGAGING

B. R. Colby and R. Woodburn, Oxford. --Stage records of runoff from several of the larger stations on the Pigeon Roost Watershed have shown a secondary "hump" in the recession graph of stage vs. time. As determined by flow measurements, discharge actually decreases during these secondary rises in the gage height. Preliminary evidence indicates that a great deal of change takes place in the surface configuration of these sand bed streams during flow. With a given fairly low velocity, the sand bed is covered with small waves or ripples, sometimes called dunes. As the velocity of flow increases, these small dunes tend to disappear and a smooth plain and fairly firm surface develops. As the velocity increases further, the bed tends to develop long waves of the sine or cosine type. There is frequently a train of waves present on the water surface at the same time the antidune condition exists on the bed. This, perhaps, explains the secondary "hump" on the hydrograph. As discharge decreases, a point may be reached where the sand bed changes to provide greater friction and the depth of flow may therefore increase with a decrease in average velocity. More work is contemplated on this problem.

LIST OF RECENTLY PUBLISHED PAPERS AND PUBLICATIONS

Some of the recently published papers and publications written solely or jointly by staff members of the Soil and Water Conservation Research Division are listed below.

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